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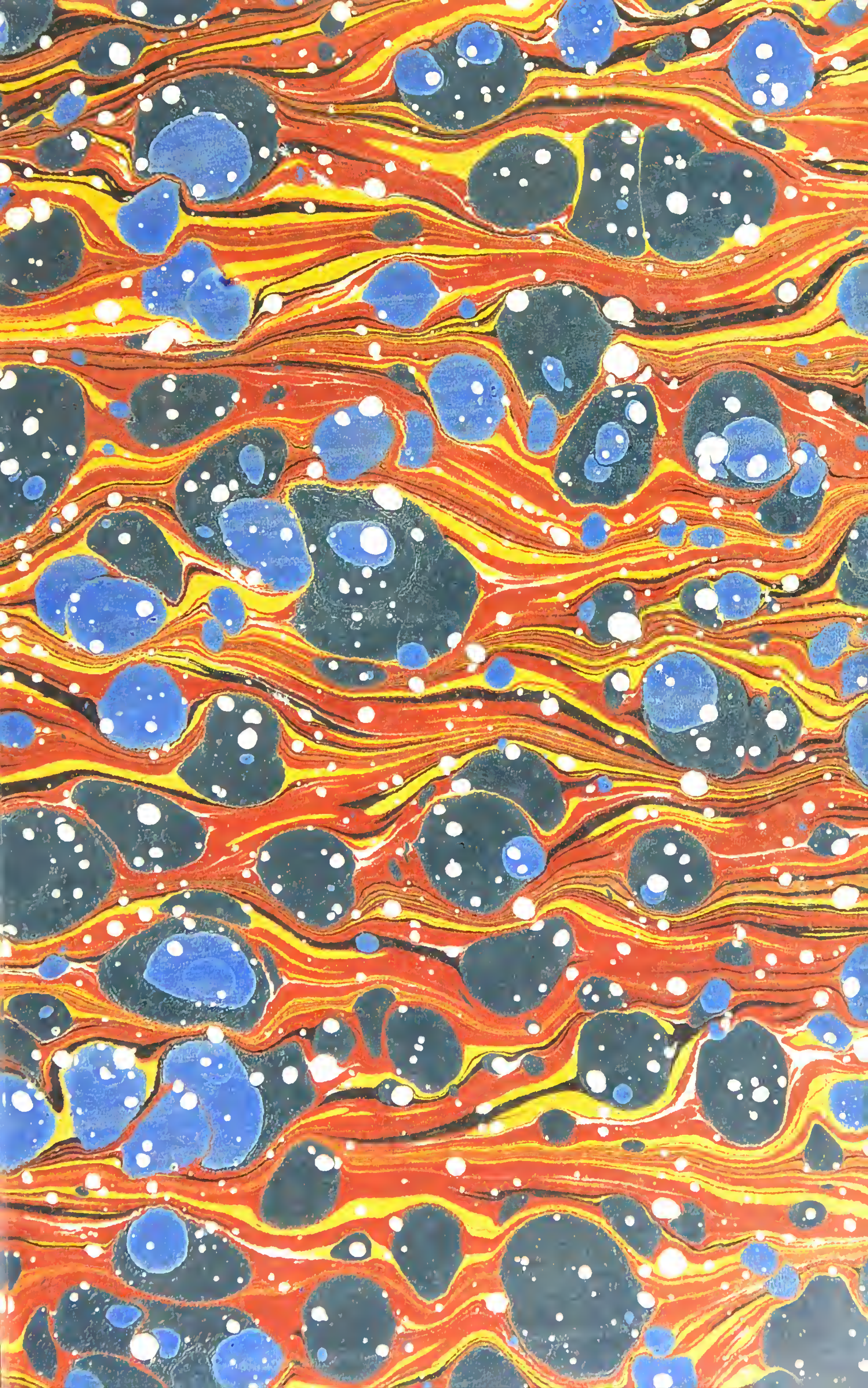

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A

SYSTEM OF SURGERY.

VOL. III.

OPERATIVE SURGERY; DISEASES OF THE ORGANS OF
SPECIAL SENSE, RESPIRATION, CIRCULATION,
LOCOMOTION, AND INNERVATION.

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A

SYSTEM OF SURGERY,

THEORETICAL AND PRACTICAL,

IN

TREATISES BY VARIOUS AUTHORS.

EDITED BY

T. HOLMES, M.A. CANTAB.

ASSISTANT SURGEON TO ST. GEORGE'S HOSPITAL, AND SURGEON TO THE HOSPITAL FOR SICK CHILDREN.

IN FOUR VOLUMES.

VOLUME THE THIRD.

OPERATIVE SURGERY; DISEASES OF THE ORGANS OF SPECIAL SENSE, RESPIRATION, CIRCULATION, LOCOMOTION, AND INNERVATION.

LONDON:
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PREFACE TO VOLUME THIRD.

THE present Volume contains the Essays on Operative Surgery, and on the Diseases of the Organs of Special Sense (the Ear and Nose; those of the Eye having been placed in Vol. II. for the sake of convenience), of the Air-passages, and of the Organs of Circulation, Locomotion, and Innervation.* In treating of Operative Surgery, it was thought inexpedient to offer a complete separate treatise on the whole subject; since, if that plan had been followed, a great part of the matter of such treatise must necessarily have been repeated in treating of the diseases of the organs on which the operations are practised. The subject of Minor Surgery has, therefore, been treated at such a length as seemed practically useful; then the greater operations are illustrated by a description of the various amputations, and an Essay on Anæsthesia; and finally, the principles of Plastic Surgery are explained and illustrated by the description of such operations as could be conveniently separated from that of the lesions for which they are practised. The Editor is aware that some amount of confusion is produced by this arrangement while the work is unfinished; but he trusts that the Index which will accompany the concluding Volume will obviate such confusion in the completed work, and enable the reader to find at once the place at which any operation is described.

---

* Besides these completed sections, the Diseases of the Organs of Digestion are commenced, by a treatise on the Affections of the Tongue. The Essays on the Diseases of the other parts of the Mouth, and the remainder of the alimentary tract, will form the commencement of the Fourth Volume.

The Editor has to apologise for a slight delay in producing this Volume; but such delays can hardly be avoided when many men, all of them in active employment, have to work together. The preparation of the concluding Volume is considerably advanced, and it will in all probability be published in a few months.

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SURGEON TO ST. GEORGE'S HOSPITAL.

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By T. Holmes, Esq.

SURGEON TO THE HOSPITAL FOR SICK CHILDREN, AND ASSISTANT SURGEON TO ST. GEORGE'S HOSPITAL.

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By Athol A. Johnson, Esq.

LATE SURGEON TO THE HOSPITAL FOR SICK CHILDREN.

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ON EXCISION OF BONES AND JOINTS.

By T. Holmes, Esq.

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By A. Shaw, Esq.

SURGEON TO THE MIDDLESEX HOSPITAL.

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PHYSICIAN TO THE HOSPITAL FOR EPILEPSY.

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ASSISTANT SURGEON TO ST. BARTHOLOMEW'S HOSPITAL.

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NOTE TO THE ESSAY ON ANEURISM.

In discussing the question of Abdominal Aneurism and its treatment (page 519), the writer has alluded to the possibility of attempting the old operation. Since those pages were in print, a most remarkable case has been put on record by Mr. Syme, which will be found in the forthcoming (45th) volume of the *Medico-Chirurgical Transactions.* This operation, which may be characterised without hesitation as one of the most daring and brilliant ever performed by any Surgeon, consisted in laying open the sac of a large aneurism situated at the bifurcation of the common iliac artery, the circulation in the aorta being controlled by the clamp described by Mr. Lister at page 90 of this volume, and tying the arteries which communicated with the sac, viz. the common, internal, and external iliac. The patient recovered.

MINOR SURGERY.

THE following essay is not intended to embrace all matters usually included under the term "Minor Surgery," since many of these will be found scattered through this work, being treated of under the special diseases or particular localities with which they are more immediately connected. Nor does it attempt to enter into the minute details found in systematic works on minor surgery; but its aim is to describe briefly such proceedings in that branch of surgery as are for the most part general in their application to the several regions of the body, and are used in the treatment of many and various diseases.

BANDAGES, AND THEIR APPLICATION.

Bandages are appliances adapted, according to circumstances, to maintain uniform pressure on subjacent parts, to retain in position fractured or dislocated limbs, to assist in maintaining contact between the edges of large wounds, or to aid in the application of topical remedies to various parts of the body. For ordinary purposes they are made of linen or calico; in particular instances flannel, or some other elastic material, is employed, being torn into strips of appropriate length and width, and prepared for application by rolling up: these pass under the conventional name of rollers. Rollers may be single-headed, where the bandage is rolled up from one end alone, the other remaining free; or double-headed, where both ends of the bandage are rolled up each into a separate coil towards its centre.

To meet the varying requirements of various parts of the body, and to fulfil the diverse conditions for which they may be needed, ingenuity has devised a most extensive variety in the construction of bandages and in the manner of their application.

The more useful forms of bandage may, however, be included in two groups: (1) the simple or continuous; (2) the compound bandages. Under the term 'simple' may be included those in which a continuous roller is employed; these are the circular, spiral, figure-of-eight, and scalp bandage. Compound bandages are such as require more than a continuous roller for their proper adjustment; these may be enumerated as the many-tailed, the four-tailed, the suspensory, and the T-bandage, besides others which will not here be referred to, as their preparation and application belong rather to the province of the instrument-maker or bandagist.

Of simple bandages, by far the most useful and most general in its application is the spiral. It consists in a continuous spiral application of a roller, each succeeding fold overlapping the one that went before it by about one-third of its width; it is used on the fingers, the upper and lower extremities, the thorax, and abdomen. This form of bandage is in all cases applied from below upwards, or from the extremities towards the trunk. So long as the part to which it is applied is of uniform calibre, as the forearm for a short distance above the wrist, the bandage may be simply rolled around the limb, passing from left to right as it crosses the anterior aspect; but if the circumference of the limb gradually increase in size from below upwards, as the calf of the leg or upper part of the forearm,

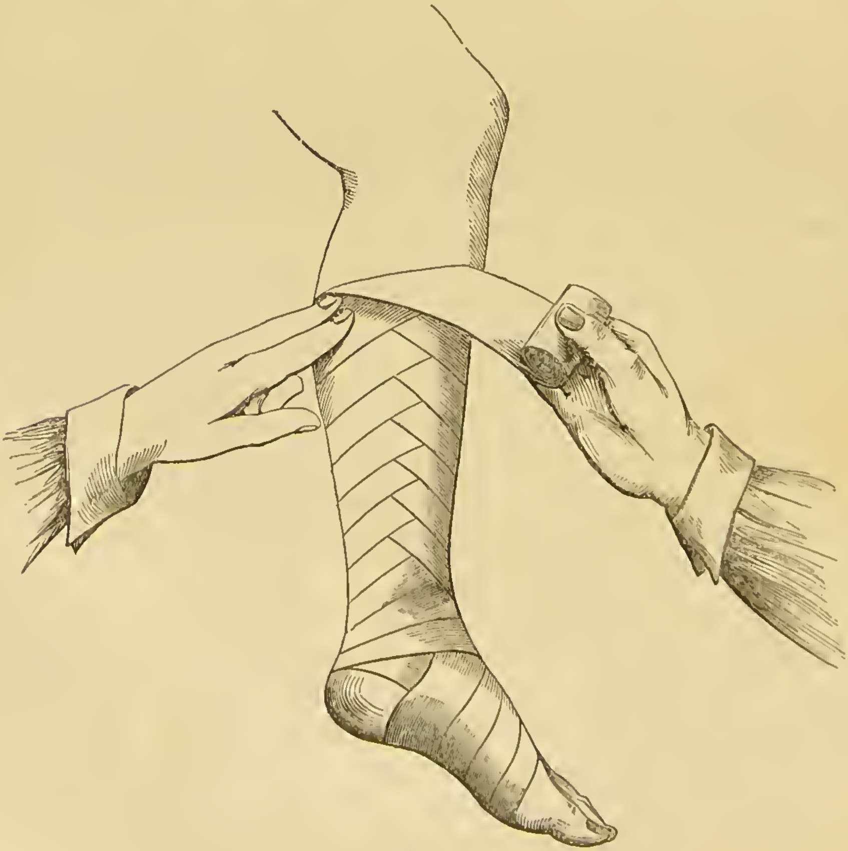

fig. 1.

the bandage must be folded on itself in the manner represented in fig. 1. This proceeding should be effected at each turn of the roller, and should always take place opposite the same point in the circumference of the limb, or an unsightly appearance will be produced. Its effect is to distribute the pressure evenly over the surface of the part, and to obviate the risk of the bandage slipping. By referring to the adjoining woodcut (fig. 2), it may be seen at what parts of the body it is generally necessary to turn the bandage, in the manner above mentioned.

The spiral bandage is not well suited for passing smoothly over the angles of flexion or extension of joints, and for this reason the other variety of simple bandage, the figure-of-eight, is employed in conjunction with it in bandaging certain parts of the body. Thus to bandage the lower extremity, taking the head of the roller in the right hand and its free end in the left, the outside of this end should be laid on the dorsum of the foot, and fixed by a turn or two of the roller. Passing over the limb from left to right, carefully keeping the bandage in an uniform state of tension, with as little of it unwound as possible, it may be now applied in a simple spiral manner, the roller changing hands each time it passes around the foot. The enlargement at the instep requires that the bandage be twisted on itself; over the ankle-joint it must be applied in a figure-of-eight fashion; again, at the lower part of the leg, it may be simply rolled around the limb, and higher up it must again be twisted on itself; and so on, varying in its method of application with the varying conformation of the part (fig. 2, A). It may be fastened off by pinning its end to the last fold applied; or the end may be split into two, and these, being carried in opposite directions around the limb, may be tied together where they meet.

The peculiar shape of the thorax, increasing as it does in circumference from below upwards, requires that a roller applied to that part, commencing from below, should be turned on itself as it ascends. Before applying a bandage to the thorax, a wide piece of roller, about five feet in length, should be split lengthways from its centre for about half a yard; this being thrown over the head of the patient, the ends may be allowed to hang down in front and behind. The patient standing with his back towards the Surgeon, his hands raised above his head and resting against some support, the bandage may be applied over the neck-piece, beginning from below. It may be finally fastened off and secured from slipping in the manner represented in fig. 2, C.

The figure-of-eight bandage is formed of a single continuous roller, and is admirably adapted for passing over the angles of the joints; and here indeed it is almost exclusively employed: as at the ankle, the knee, the groin, over the metacarpal articulation of the thumb or finger, over the elbow-joint and shoulder. Again, it is made use of to keep the shoulders apart, or to draw them together, according as it crosses in front or behind the body. At the ankle the crossing of the bandage is so arranged as to fall in front of the ankle-joint, while the two circles of the figure embrace respectively the leg and foot (fig. 2). At the groin the two circles of the figure

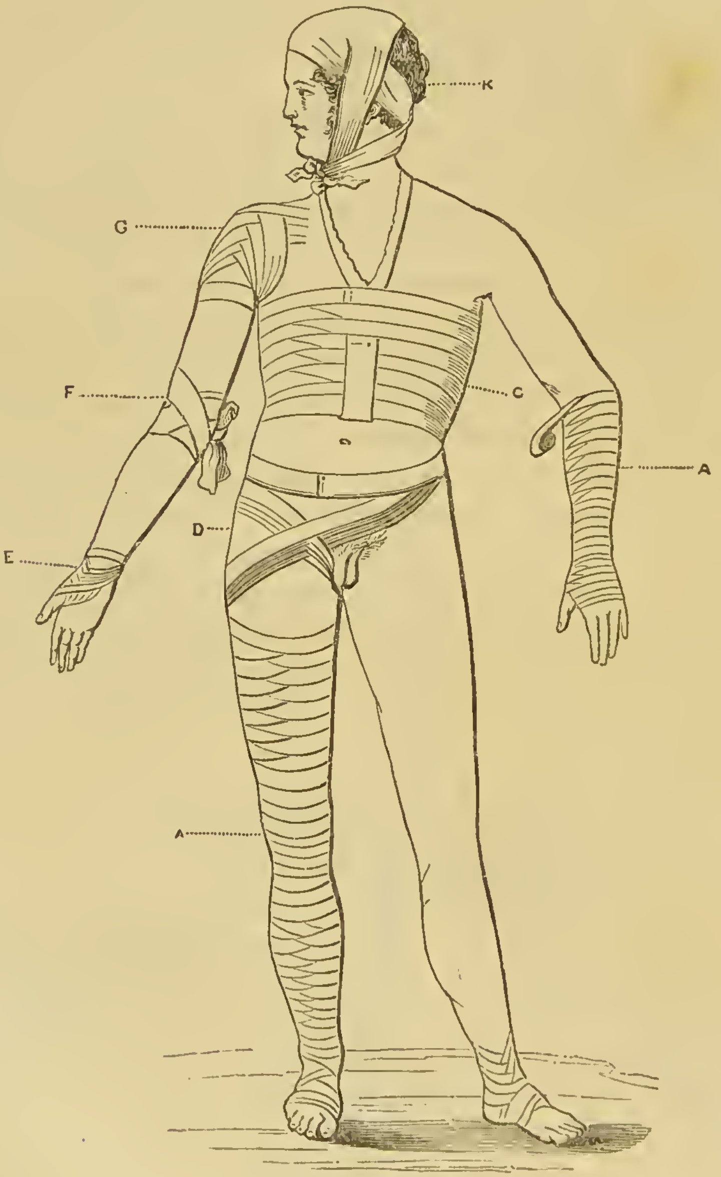

fig. 2.

should surround, the one the upper part of the thigh, the other the pelvis; this form of bandage is generally applied after operations for strangulated hernia, the crossing of the roller being arranged so as to fall over the situation of the internal abdominal or femoral ring (fig. 2, D). In applying the figure-of-eight to the thumb, one limb of the figure should surround the root of the thumb, while the other passes around the wrist, the crossing of the bandage being situated over the subcutaneous margin of the metacarpal bone (fig. 2, E). At the elbow this form of bandage embraces the upper arm and forearm, and crossing over the flexure of the joint is thus made available for compressing the orifice of the vein after venesection as ordinarily performed (fig. 2, F). In bandaging the shoulder, the roller is passed around the upper part of the arm on the one side, and around the root of the neck, or under the opposite shoulder, on the other; the crossing of the bandage will thus lie over the prominence of the head of the humerus (fig. 2, G). The figure-of-eight, as employed for fractures of the clavicle, crosses over the situation of the spines of the upper dorsal vertebræ, and surrounds the shoulder-joints on either side, passing in front of them; when it is desirable to bring the shoulders forward and maintain them in this position, the bandage is arranged so as to cross over the front of the sternum and surround the shoulder-joints on either side, passing behind them (fig. 3). This form of bandage may be made available for compressing or supporting one or both breasts, being passed round the thorax under the affected breast and over the opposite shoulder. At the articulation of the knee the figure-of-eight is occasionally employed to bring together the fragments of the patella after transverse fracture of that bone; for this purpose the circles of the figure must the one surround the leg, the other the thigh, the bandage being crossed in the popliteal space. For other purposes the bandage is reversed, and so applied that the crossing falls over the front of the articulation.

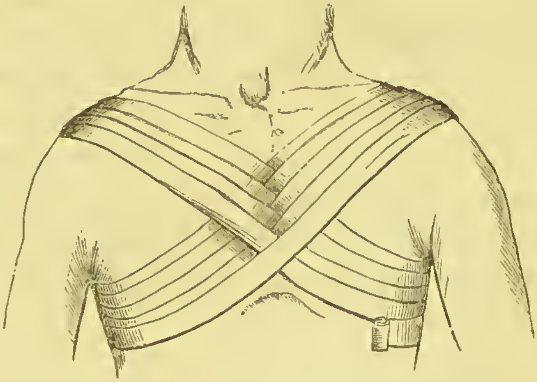
fig. 3.

Of *scalp-bandages* there are two principal varieties, the knotted and the recurrent; they are employed for retaining local applications to wounds of the scalp, or for exercising pressure on the part to control hæmorrhage. The knotted bandage, which is generally employed for compressing the temporal artery, is applied in the following manner. A bandage, about two inches in width and four yards in length, being rolled up at either end into two separate and unequal portions, the Surgeon taking one head of the roller in each hand, and standing facing the wounded artery, applies the unwound portion of the bandage over the compress. He should now pass his hands around the head, one on either side, so as to encircle it with the roller until he reaches the opposite temple, when the two heads of the bandage being crossed, they may be brought back again to the point of departure. Here, being crossed one over the other, their direction should be changed, one end being carried under the chin, the other over the vertex, so that they may again meet over the opposite temple, where they are again to be crossed and carried around the head, one on either side, to the point whence they first started. Here, again, they are crossed, carried respectively under the chin and over the vertex, and so on until sufficient compression is exercised over the wounded vessel. The application may be secured in position by a few circular turns of the long end of the roller (fig. 4).

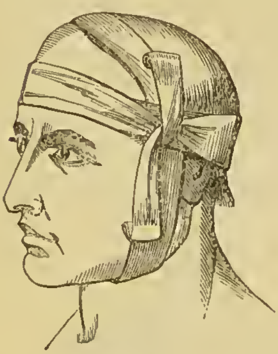
fig. 4.

The recurrent or capeline bandage is difficult of application, and easily becomes displaced. As it is almost impossible to convey a proper idea of the manner in which it is adjusted by a mere verbal description, no further allusion will here be made to it.

Compound bandages. The T-bandage, the four-tailed, the many-tailed, and the suspensory bandage, fall under this denomination. The T-bandage is formed of two pieces of linen roller attached to each other in the manner indicated by the name of the application. It is principally used in the neighbourhood of the perinæum, where it is well adapted to maintain pressure on the parts, or to retain in position any topical application.

In applying the bandage, that part of it represented by the horizontal limb of the T being passed around the body just above the crests of the ilia, should be fixed by tying together the ends in front of the belly, in such a position that the vertical part of the bandage shall be situated over the spines of the lumbar vertebræ; if the application is to be adjusted to a female, the loose end may now be brought forward between the nates and in front of the vulva, and attached to the horizontal portion in the median line of the abdomen. If the patient is of the opposite sex, the vertical part of the bandage should be split at its free end, and the two ends brought up one on either side the scrotum and penis to be attached to the part of the bandage that encircles the body. As a ready and efficient substitute for the linen roller, two pocket-handkerchiefs may be used in the application of this form of bandage.

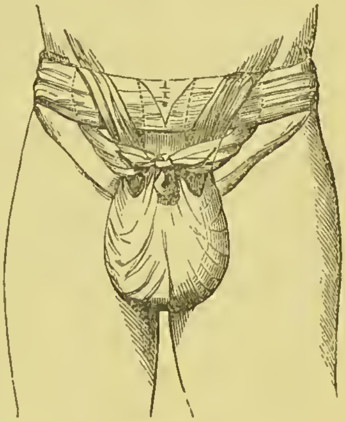
fig. 5.

Suspensory bandages are to be procured ready for use of an instrument-maker, though occasionally they must be improvised by the Surgeon; for such an emergency, a handkerchief or a piece of bandage being tied around the abdomen just above the crests of the ilia, a second handkerchief should be passed beneath the scrotum, and attached in the manner represented in figure 5.

The *four-tailed bandage* is made by taking a piece of linen about six inches wide and a yard and a half long, and splitting it up the middle from either end to within three or four inches of the centre; this would form such a bandage as might be applied over the knee; but of course the size of the apparatus must be regulated by that of the part of the body to which it is to be adapted. The form of bandage under consideration is generally employed for maintaining in position topical applications, but is occasionally made use of to secure the correct apposition of fractures; it is applied over the knee-joint, to the lower jaw, and on the vertex. To adjust this bandage to the knee-joint, the centre of it should be placed on the patella, the four tails, being passed around and under the knee and crossed behind the limb, should be brought forward again, the lower pair being tied together in front of the thigh above the patella, the upper pair over the head of the tibia on the anterior aspect of the leg. For the lower jaw the bandage should not be more than three or four inches in width, and a hole should be cut in its centre to admit the prominence of the chin: in adjusting it, the centre of the bandage should be placed under the chin, and the tails being carried upwards, the hindermost pair should be tied over the vertex about the situation of the coronal suture, while the anterior pair of ends are taken backwards and fastened together above the occipital protuberance. When

applied to the vertex, the bandage should be wider than that required for the chin; its centre being placed on the vault of the skull, the posterior tails should be brought down and tied together beneath the chin, while the anterior pair are carried backwards and fastened beneath the occiput, or brought round again under the chin (fig. 2, K).

The *many-tailed bandage.* The advantage of this form of application is, that it can be applied and removed without any disturbance of the parts to which it is adjusted; and thus it is chiefly used in the treatment of compound fractures, in the dressing of stumps after amputation, or in any case where absolute quietude is desirable. The bandage is constructed in the following manner: to a wide piece of roller, rather longer than the part of the limb to which the bandage is to be applied, should be stitched in succession several shorter portions of a narrower bandage; these should be attached by their centres in such a manner that each piece is at right angles to the long roller, and overlaps the preceding piece by one-third of its width. These shorter portions should be each about half as long again as the circumference of the limb they are to surround. This bandage, like the spiral, should be applied from below upwards; the back piece should be drawn up behind the limb or part which is to be bandaged, and the transverse portions spread out evenly on either side, the last piece sewn on standing first in order for application. Beginning from below, the opposite ends of these transverse pieces should be crossed over each other around the limb, each succeeding pair overlapping and keeping in place the ends of bandage that immediately preceded them (fig. 6); the last pair may be tied together, or kept in position with a pin.

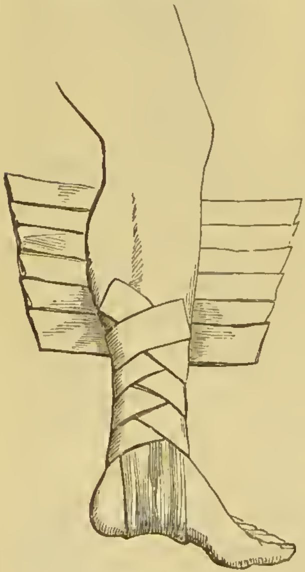
fig. 6.

Immovable Apparatus.

Under this head it is proposed to consider those methods of bandaging by which support and immobility are secured; the essential principle of the application being that it admits of adaptation while in a moist and pliant condition, and is thus enabled the more exactly to accommodate itself to the conformation of the parts to which it is applied, before assuming its permanent condition of immobility.

Gum and chalk, white of egg and flour, gypsum, starch, dextrine, leather, gutta-percha, millboard, pasteboard, are any of them made use of in combination with the ordinary bandage for the above-named purpose. These forms of immovable apparatus are employed in the treatment of fractures, in chronic joint-affections, and other diseases where it is necessary to maintain permanent immobility or pressure.

Gum and chalk is prepared by rubbing together in a mortar mucilage with a sufficient amount of chalk to form a mixture about the consistence of thick cream. The limb being placed in the position in which it is desirable it should be retained, should be protected over its more prominent points with a layer of cotton-wool. Having been firmly and evenly bandaged, the gum and chalk may be smeared over the roller with a brush or the open palm of the hand; in doing this the hand or the brush should be applied to the part in the same direction as the spiral of the roller, that is, around the front of the limb from left to right. If a great amount of rigidity is required, a second bandage may be applied, and treated in the same manner; or the apparatus may be still further strengthened by combining with the bandage gutta-percha, leather, or pasteboard splints moulded to the parts while in a pliant condition. These should be applied to the limb immediately over the cotton-wool sheathing, and they may be retained in position during the application of the first bandage by strips of adhesive plaster. The gum and starch bandage takes from four to five hours to dry, and during this time, if there is any considerable tendency to displacement in the limb, means must be used to counteract it until the application has become rigid. For this reason it is that the plaster of Paris, or gypsum bandage as it is called, is preferred by many to the gum and starch.

The gypsum bandage. For this form of application a roller, which should be of coarse and open material, must be previously prepared by rubbing into its texture dry powder of plaster of Paris. The Surgeon should have at hand a bag of the same material and a basin of water. The limb being protected with a layer of cotton-wool, the prepared roller should be immersed in water for about a minute; it is then ready for immediate application. It should be rolled around the limb in a spiral manner, just as an ordinary bandage; after every second or third turn of the roller, the left hand should be plunged into water and smeared over the part last applied. When the whole has been thus treated, the exterior of the bandage should be rubbed over with a paste of plaster of Paris and water, until a smooth surface and sufficient rigidity have been attained. This form of application, after the lapse of ten minutes or a quarter of an hour, will have acquired its permanent condition of rigidity.

Starch, white of egg, and dextrine, are all used in their fluid forms as stiffening materials for bandages. The roller may be soaked in a solution of one or the other of these substances previous to its application; or again, the roller being cut into short pieces, each half as long again as the circumference of the limb, these portions may be applied separately to the part from below upwards; the opposite ends of each piece crossing one another, over the anterior aspect of the limb, and each succeeding piece overlapping the one that went before it by one third of its width. Strips of paper soaked in any of the above-named solutions may be advantageously applied in the manner just described.

Gutta-percha, *pasteboard*, *millboard*, or *leather*, may be used in combination with any of the above stiffening materials to give additional firmness and permanency to the application. These, being cut into pieces of the required dimensions, must be moulded to the shape of the part while in a pliant condition.

Gutta-percha is rendered fit for application by plunging it for a minute or two into *hot* water. Millboard, pasteboard, and leather, may be prepared for use by soaking them for a sufficient time in *warm* water. Before applying splints formed of these materials to a limb, the whole part should be carefully swathed in a layer of cotton wool. In many hospitals it is the practice first to envelop the limb in a dry roller, and, having moulded pasteboard splints to fit the parts, to fix these by applying a bandage previously saturated with a thick solution of starch.

In adjusting the immovable apparatus to a compound fracture, or to any part where it is desirable that an aperture should exist for the escape of matter or for the dressing of a wound, the application should be effected in the ordinary manner, and subsequently the bandage over the wound or sinus may be cut away to the necessary extent.

One great advantage attaching to the form of apparatus under consideration is the manner in which it may be adapted to changes in the size of the limb. When, from swelling of the parts beneath, it is necessary to loosen the bandage, the whole application should be cut from end to end with strong scissors or a knife, on the anterior aspect of the limb; this will entirely relax the parts. Subsequently the degree of support and pressure to be exercised may be regulated by passing straps and buckles around the case in which the limb now lies, and tightening or loosening these as occasion may require.

Where, from subsidence of swelling or other causes, it becomes necessary to tighten the application, a longitudinal strip may be cut out of the apparatus from end to end, and with straps and buckles the sides of the case may be brought more nearly into apposition.

There is sometimes considerable difficulty in removing the so-called immovable apparatus; this may be overcome by surrounding the parts with a wet cloth for some time before the removal is attempted. When the bandage is thoroughly soaked, it may be uncoiled from above downwards with little difficulty, or it may be cut with scissors, layer by layer.*

Sutures, and their Application.

Sutures are used for bringing together and maintaining in contact the opposed surfaces of wounds. They differ both in the method of the application and the material of which they are composed: this difference is owing to the varying necessities of wounds, as these vary in character, or occur in one or another part of the body. There are four principal varieties in the method of applying sutures: (1) the continuous; (2) the interrupted; (3) the twisted; (4) the quilled; in these the material employed may be silken or hempen thread, iron or silver wire.† Under the head of each of the principal forms of suture, the material of which it may be composed will be referred to more particularly.

To save subsequent repetition, certain general principles applicable to all forms of suture will be noticed. In passing the needle, the edges of the wound may be advantageously held in contact with the forefinger and thumb of the left hand, or they may be simultaneously tightened so as to bring them parallel to each other, that their opposite and corresponding parts may exactly coincide. The needle should penetrate the surface at an angle of 50°, and should at least pass through the whole thickness of the integument at each stitch; as a general rule, the thread should penetrate to a sufficient depth to avoid leaving beneath it in the wound any considerable cavity or space in which pus can accumulate. The distance from the edge of the wound at which the suture should enter and leave the part, must necessarily vary with the depth of the wound and the amount of tension to which the thread will be subject; but in no case should there be less than the eighth of an inch between the suture-hole and the margin of the wound. Sutures, as a rule, ought not to include vessels, nerves, fasciæ, muscles, or tendons. Where more than one suture is used, the interval between the points of suture in the wound should be sufficiently small to overcome any tendency there may be for the edges of the wound to evert, or the fat and subcutaneous tissue to bulge. The line of the thread ought to cross that of the wound at right angles; and in cases where the thread has to be tied, care should be taken that the knot may fall on one side of the line of contact of the edges of the wound. A single knot having been tied, some precaution should be taken to prevent it slipping while the second knot is prepared. This may be tied firmly, but need not be tightened by the exercise of any force; the fingers are sufficiently strong to effect its proper adjustment, without making unnecessary or unseemly muscular efforts.

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* Or a piece of wide tape is laid beneath the bandage at the time of its application, the lower end being left hanging out; this is used to raise the bandage upon, while it is divided with the scissors.

† The shotted suture, the clamps and other forms attaching themselves to special regions of the body, will be found described in the essay on Plastic Surgery, and in the account of the various plastic operations.

The size of the needle employed for passing continuous or interrupted sutures should be adapted to that of the thread to be carried, and to the depth of the tissues to be traversed. The shape of the needle, whether straight or curved, should bear relation to the situation and nature of the wound. For incised wounds on the exterior of the body, where the edges can only be transfixed from the cutaneous surface, or where the opposite margins of the wound can both be traversed by one plunge, a curved needle is best adapted; whereas a strong straight needle is more convenient for the completely free margins of extensive wounds, such as are left by the removal of large tumours, or after amputations.

The continuous suture is for the most part used for the accurate apposition of wounds having thin and delicate edges, such as those of the eyelids or intestines. The application consists in the simple sewing together of the wound from side to side; the thread being knotted at its extremity, to prevent its pulling through. This form of suture may be fastened off by knotting together the free end of the thread with the stitch last passed; it can be removed by cutting with fine-pointed scissors each portion of the thread as it passes across the line of the wound, and subsequently withdrawing these portions separately. Silk or fine thread is generally used for the continuous suture, and the needle should be small and curved at its point.

The interrupted suture is more general in its adaptation than any other form, being used in wounds of almost every description. Although from its very nature it does not maintain the surfaces of a wound in such close and absolute contact as can be secured by the continuous or twisted suture, yet it possesses certain advantages over these, both in the facility with which it is applied and subsequently withdrawn (piecemeal if need be), and in that while it puts the parts in such a condition that union is most likely to take place, yet, in the event of the healing process being retarded, it offers no serious obstacle to the discharge of matter. For the application of this suture the needle may be either curved or straight, its form varying with the disposition of the parts to which it is to be applied. The needle, being passed through the integuments a short distance from the edge of the wound, may be made to traverse its cavity, and appear through the skin at the same distance beyond its opposite margin. The peculiarity from which is derived the name of this form of suture, consists in the cutting of the thread after each complete stitch, and tying the ends together, over, or rather just on one side of, the line of the wound. In wounds with edges of considerable thickness and extent, the needle is generally passed separately through the opposite margins, being first introduced from the cutaneous surface towards the deeper aspect of the parts, and subsequently from the cavity of the wound towards the surface of the body.

Silken and hempen thread, the materials formerly made use of for the interrupted suture, have now very generally given place to silver or iron wire. These latter possess most decided advantages over silk, or any thread of vegetable origin, in their cleanliness, and in the diminished tendency they show to excite irritation in the tissues through which they pass.* For the introduction of metallic wire, as a substitute for threads of organic origin, we are greatly indebted to Dr. Simpson of Edinburgh, who, by the publication of the results of his experiments on animals, and by the success that attended his use of the same suture in man, first drew general attention to the subject in this country. In 1849, Dr. J. Marion Sims was the first to apply the same description of suture in

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* My personal experience, in opposition to Dr. Simpson's observations, leads me to give a decided preference to silver over iron as a material for metallic suture, and this is, I believe, in accordance with the opinion entertained at most of our metropolitan hospitals.

America.* Dr. Sims' claims to priority had, however, been anticipated (at least so far as the principle involved was concerned) some two hundred years before by Fabricius ab Aquapendente, who, writing in 1647, refers to the imperfections of the materials for suture at that time in use, namely, that they excited irritation, produced discharge, and easily ulcerated out. As a substitute, he recommends iron or brass wire sharpened at one extremity and annealed elsewhere, thus forming both needle and suture of one continuous piece of metal.† Again, in our own country, in the year 1834, Mr. Gossett‡ successfully treated a case of vesico-vaginal fistula by silver-gilt wire sutures, and curiously enough, adopted the same position for the patient that is now found most convenient for the performance of the operation; a position, the advantages of which Dr. Marion Sims professes to have been the first to discover.

For carrying a metallic thread, an ordinary needle of rather large size, and pretty deeply grooved behind the eye, may be employed, or one of those specially made for passing this description of suture. Of these there are three varieties, namely, that invented by Mr. Price, having two eyes, and being deeply grooved (fig. 1); Mr. Lister's, furnished with one eye, and grooved laterally (fig. 2); and that recommended by Mr. Murray, having an open end, and a groove on the side to admit of the end of the wire being doubled on itself (fig. 3). To obviate the necessity of employing a needle at all in the use of metallic sutures, a piece of thin steel pianoforte-wire may be sharpened off with a file at one end, while the remainder of the wire may be annealed by keeping it at a dull red heat for some little time, and allowing it to cool slowly; two or three short coils of such wire are easily prepared, and form a useful addition to a pocket-case. Silver wire, if kept long, soon loses its softness and pliability, and becomes unfit for sutures; it may be reannealed at any time, and best of all just before it is required for use. Metallic sutures are fastened off by first crossing, and

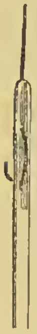
fig. 1.

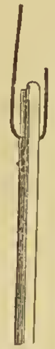
fig. 2.

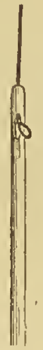
fig. 3.

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* Anniversary Discourse, 1858, before the New-York Academy of Medicine.

† See Dr. Aveling's letter to *Medical Times and Gaz.*, Jan. 22, 1859, where the whole passage from Fabricius is quoted at length.

‡ *Lancet*, Nov. 29, 1834.

then twisting, the opposite ends of the wire together, until sufficiently secure to resist the tension to which they will be exposed. In applying these sutures to the prepuce or elsewhere, where the edges of the wound are thin and delicate in structure and the tissues around of lax disposition, some care must be taken lest the edges of the wound themselves be twisted and bruised in the process of fastening the suture.

When the interrupted suture is formed of silk or thread, it is easily removed by dividing it with the point of the scissors just away from the knot, grasping this in the forceps, and gently drawing out the suture. Metallic threads may be removed by cutting the wire and straightening the ends before withdrawing it, or better, by cutting away a portion of the wire,—nearly all the part exposed to view,—and withdrawing the remainder with the forceps, pulling towards the line of the wound, so as to make the wire describe a slight curve in its exit, suited to the shape which it has assumed. The foregoing is one of the best methods of removing metallic sutures, a proceeding which owing to the stiffening of the wire, is liable to be somewhat painful in its execution, unless some such plan as the above be adopted : this difficulty in their removal seems to be the great drawback to the employment of metallic sutures. It is inexpedient, particularly in hospital practice, to leave metallic sutures in a wound, in the hope that they will slough out; the wire, or at least so much of it as is beneath the skin, will in the majority of cases become encysted, and may subsequently prove a considerable source of inconvenience.* As an instance of the tolerance of metallic sutures exhibited by certain tissues, we may mention the case of a woman who still retains a silver suture in the anterior wall of the vagina, introduced by Mr. Wormald several months ago for the cure of vesico-vaginal fistula; this patient has since borne a child.

Before removing interrupted sutures, it is usual to support the intervals of the wound between them by strips of adhesive plaster; but for further information on this point the reader is referred to the essay on WOUNDS, vol. i. p. 592.

The twisted suture will retain in immediate contact the whole surfaces of a wound of considerable depth; it is employed in the operation for hare-lip, in many wounds of the face, especially such as lay open the cavity of the mouth, and in extensive wounds of the abdominal walls.

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* A fine silver ligature, which had been placed on the radial artery at the wrist, was removed three months afterwards by myself, on account of the inconvenience it caused the patient.

Hare-lip pins, cutting wire-pliers, and silk, twine, or some soft thick thread, are required for its application.

The edges of the wound being held in contact, or at all events being carefully maintained in the same horizontal plane, the pin should be made to transfix the wound, entering the skin from half an inch to an inch from one of its margins, and appearing at the same distance beyond the opposite. The requisite number of pins having been passed, a piece of silk, or whatever other material is chosen for the suture, should be twisted over each pin in the form of the figure 8, so that the circles of the figure surround the extremities of the pin, and the crossing of the thread lies over the line of the wound. The same thread may be made to serve for all the sutures, provided it is sufficiently long, being passed continuously from one pin to the next below it. The opposite ends of the ligature being tied together, each pin may be shortened at its pointed extremity, and adjusted so as to leave about half an inch projecting on either side. The skin may be protected from these rough-cut ends by passing beneath them a strip of soft lint; and the whole is best covered with the same material dipped in oil. In withdrawing this form of suture, the heads of the pins should be grasped in the forceps, and loosened by a slight rotatory movement; they may then be drawn out, while the finger and thumb are placed on the suture itself, to prevent any traction being exercised on the margins of the wound. When the cut surfaces, to which the twisted suture is applied, are of great thickness, it is sometimes necessary to add a few interrupted sutures at the extreme edges of the wound to prevent the eversion of the fat and subcutaneous tissue.

In applying the twisted suture to the face, or elsewhere where a sightly cicatrix is a consideration, great care is needed, in transfixing the parts, to keep the margins of the wound exactly on the same level. To avoid any doubling-in of the skin, it is well to tilt up the edges of the wound while passing the pin through them.

For this suture the softer varieties of thread possess a considerable advantage over silk or twine; the latter, from the firmness of their texture, being too apt to bruise the soft parts beneath them; on this account some adopt the plan of using narrow strips of lint to wind around the ends of the pins.

The quilled suture is adapted to wounds of greater depth than those to which the preceding variety of suture should be applied;

of itself it can maintain in apposition the deeper parts of such a wound, and in conjunction with the interrupted suture it will keep in contact the whole surface. In the hands of some it is found very useful in the treatment of lacerated perinæum, or it is employed in deep wounds of the buttock and fleshy parts of the thigh. It is best applied with a strong curved needle, fixed in a handle, and having an eye near the point. This should be threaded with the loop of a double thread, formed of some stout material; and having been passed through the wound from side to side, the looped end of the ligature may be detached from the eye and held with the left hand, while the needle is withdrawn. The needle should pierce the skin not nearer than an inch from the edge of the wound, and should traverse the deeper parts, and emerge at the same distance beyond its opposite margin. This proceeding will leave a double thread through the wound with a loop on the one side and two free ends on the opposite. Through the loop (or loops if more than one suture be employed) a piece of gum catheter should be passed, and the thread drawn tightly over it, while the other ends are tied firmly over a similar piece on the opposite side of the wound. To maintain perfect apposition in the more superficial parts, it is generally necessary to add a few interrupted sutures at the extreme margin of the wound.

By cutting the looped ends of the threads this form of suture may easily be removed.

Serres-fines are occasionally employed for bringing together wounds of very thin skin or mucous membrane. They are small spring-wire forceps; their points are finely serrated, and their handles cross one another, so that when at rest they are closely in contact. The points are generally bent at right angles to the spring, so that the handles of the serres-fines may lie evenly over one another along the line of the wound in an imbricated manner. In adjusting these, one should apply them at regular intervals to the lips of the wound, taking care that the handles of each pair are turned in the same direction, so as to overlap those of the preceding pair; any dressing that the wound may need can be laid on it subsequently.

COUNTER-IRRITATION.

Counter-irritants, as their name implies, are used for the purpose of exciting local irritation; they vary in degree from simple rubefacients, which merely produce transient congestion of the cutis, to such as completely destroy the tissues exposed to their influence. They may conveniently be studied in two groups—(1) those whose effects are comparatively transient; and (2) those that excite a more permanent local irritation, or that maintain a continued drain on the system. Under the first head are included rubefacients, vesicants, acupuncture, and the like; under the second, the moxa, issues of various kinds, setons, and the actual cautery. *Rubefacients* may be generally defined as applications to the surface of the body, which irritate the cutis sufficiently to produce reddening of the parts, without leading to any of the more serious results of inflammation. For this purpose various liniments are employed, such as the linimentum ammoniæ, l. cantharidis, l. acidi acetici, l. terebinthinæ, l. olei crotonis tiglii; the potassio-tartrate of antimony in the form of ointment, and mustard-flour in the form of poultice. With the exception of the last named, all these substances may be applied to the surfaces by friction with a piece of flannel, the skin of the part having been previously cleansed with warm water; the skin may be rubbed until it has acquired a ruddy hue, and a smart tingling sensation is experienced in the parts. Croton oil and the potassio-tartrate of antimony differ from the other substances in this group, in being more decided in their effects, and in producing a characteristic pustular eruption.

Mustard-flour, the most popular and useful of rubefacients, should be made into a poultice with water of a temperature from 90° to 100°; water of a higher temperature than this is liable to coagulate the albumen of the mustard-flour, while a much lower hinders the disengagement of the volatile oil upon which the irritant property of the application depends. Vinegar, which is often mixed with the poultice, has the effect of diminishing its activity. The effect of sinapisms may be in a measure regulated by mixing with the mustard, wheat-flour or linseed-meal, and by modifying the duration of the time during which they remain in contact with the skin. The London Pharmacopœia directs that equal proportions of linseed-meal and mustard-flour be used; while the time during which the application should remain on may be broadly stated to vary from ten minutes to half an hour. It may best be estimated by observing the texture of the skin of the patient, and being at the same time guided somewhat by his expressions of pain.

When sinapisms are employed to patients in a comatose condition, special care should be taken lest they remain for too long a time in contact with the skin; and this not only on account of the absence of any indications for their removal from the sensations of the patient, but also from the possibility that the part to which they are applied may be already lowered in vitality by the loss of nervous force. This form of rubefacient may be employed to any part of the surface of the body, though it is well not to expose the skin of the face to its influence. Very delicate or irritable skins are best guarded from its undue action by interposing a thin piece of cambric or tissue-paper beneath the poultice. After the removal of the application, the surface should be gently sponged with warm water, and a piece of cotton-wool may be placed over the part; or, if the pain be severe, a piece of linen or lint smeared with simple cerate.

Vesicants are substances which, in contact with the external integument of the body, excite such irritation of the cutis as to determine the effusion of serum from its surface, leading to the separation of the cuticle, and the formation of a vesicle. As a general rule they are employed as derivatives or counter-irritants in chronic inflammatory affections; or after the more active symptoms of inflammation have passed by, they are used either to quench the smouldering remains of an acute attack, or to stimulate the absorbents to the more speedy removal of some inflammatory product.

To produce vesication, cantharidine in one of its various forms is generally employed; though liquor ammoniæ, chloroform, or iron heated to 212° F., are occasionally used; it is also said that mezereon-bark, soaked in vinegar and applied to the skin, is capable of raising a blister on the surface.

Cantharidine is employed in the form of the emplastrum cantharidis, blistering fluid, and blistering tissue. The skin of the part being previously well cleansed with warm water, or sponged with vinegar, the application should be so adjusted that it may remain in close contact with the skin; for this purpose the emplastrum cantharidis is generally spread upon diachylon plaster, and the blistering tissue can be fixed with strips of the same material. In cases where, from the delicate texture of the skin, or from known idiosyncrasy, there is fear lest urinary irritation arise from absorption of the cantharidine, the surface of the blister may be dusted over with powdered camphor, or better, a piece of oiled tissue-paper may be interposed between the blister and the skin. In no case should the application be made over a raw surface, nor, if avoidable, on the site of a recent cupping. The employment of blisters is not admissible in the case of children suffering from any low or exhausting form of disease; in them sinapisms will be found to produce quite as much irritation of the cutaneous surface as it is safe to employ. The period during which the preparations of cantharidine should be allowed to remain in contact with the skin varies so greatly, and is dependent on such diverse conditions of sex, age, and idiosyncrasy, that we cannot attempt to lay down any general rules on the subject; the patient's own sensations will afford some guide to the amount of irritation that has been excited: if the application be slightly raised, it can be ascertained whether any effusion of serum has taken place. If the blister has been applied during some hours without producing the desired effect, it will be well to remove it; and should any considerable reddening of the surface exist, a warm linseed-meal poultice applied to the part will often suffice to determine a copious effusion of serum from the surface of the cutis.

Vesication may be more rapidly produced by the application of the liquor ammoniæ, or iron heated in boiling water, to the surface of the body. These agents are but rarely employed in this country, though the one or the other might be advantageously employed where rapid denudation of the cutis is required, for the application of remedies by the endermic method. One of the best plans of using the liquor ammoniæ is to steep a piece of lint the size of the part to be vesicated in the strong solution, and apply it to the skin until the ammonia has passed off by evaporation; in most cases this will almost immediately raise a blister. A very manageable and speedy counter-irritant, which at the same time appears to possess a certain local anæsthetic property, has been introduced by Mr. Little, of Singapore. It consists of a small piece of lint steeped in chloroform, and covered entirely with a watch-glass, applied to the skin and gently pressed down with the palm of the warm hand. It may remain in contact with the skin from five to ten minutes, when it will generally be found to have produced pretty decided reddening of the part, and occasionally vesication. This application has been found especially suited for facial neuralgia, or rheumatic affections of the sciatic and other nerves.

To apply the heated iron as a vesicant, an ordinary hammer with a flat head, or better Dr. Corrigan's thermal hammer, as it is called, should be plunged into boiling water for about a minute, dried, and immediately applied to the part to be blistered; the contact of one or two seconds is sufficient to produce the desired effect. Such a hammer immersed in water at 120° F., and held for two or three seconds in contact with the skin, will act as a rubefacient; while, if allowed to remain in contact from five to ten seconds, it will generally produce vesication.

Whatever means are employed to produce the effusion of serum beneath the cuticle, the subsequent treatment of the vesicle must be pursued with one of two objects in view; either to render the injury to the part as transient as possible, and to restore the integrity of the cuticle, or to establish a permanently secreting surface. To effect the former, the vesicle, being opened with a large puncture at its most dependent part, may be allowed to empty itself; subsequently it may be covered with a layer of cotton-wool, which can remain undisturbed until the new cuticle be formed beneath; or after the evacuation of the serum, the part may be dressed with simple cerate spread on linen or lint. If, however, the blister is to be kept open, the cuticle being pinched up with the forceps may be divided with the scissors around the circumference of the vesicle, and removed at once, the raw surface being dressed with the ceratum sabinæ, or whatever other application is selected as an irritant. This process of stripping off the cuticle, and at once exposing the denuded cutis to an irritant ointment and the external air, is extremely painful; the pain may, however, be avoided by leaving the cuticle in contact with the surface of the part after dividing its connexions in the manner above described; the dressing may be applied over the cuticle, and the latter will separate in a few days, thus leaving a raw surface that will gradually have become inured to the stimulus of the external air.

Various irritating applications are made use of to maintain a constant secretion from blistered surfaces; the unguentum sabinæ, or the ceratum and unguentum cantharidis, are usually employed, spread on lint or linen rag. A convenient and nearly painless irritant is found in the *papier épispastique*, which is kept by most chemists: at each fresh dressing the part should be cleansed with warm water; a process needed as a general rule every day, and in summer weather twice during the twenty-four hours. There is a limit to the time during which a blistered surface should be kept discharging; when the granulations become large, spongy, or tuberculated in appearance, it is well to discontinue irritant applications, lest an uneven and unsightly cicatrix be produced.

When vesication has been employed to allow of the introduction of drugs into the system by the endermic method, the blister may be opened by a small puncture, which should not be situated on the most dependent aspect of the vesicle. The serum being pressed out, the substance to be administered may be introduced through the opening in solution, by means of a small syringe, or it may be applied in powder to the raw surface of the cutis. The foregoing method is now, however, superseded by the introduction of Dr. Wood's syringe and hollow needle, by means of which substances can readily be introduced into the subcutaneous cellular tissue.

This manner of introducing drugs is peculiarly adapted to the administration of anodynes: it has now received a fair trial in many of our metropolitan hospitals, and has met with general approval. The action of morphia given in this way is as speedy, if not more so, than when given by the mouth; it has the advantage of producing no disordering effects upon the stomach; while from the manner of its administration it can be given in conditions when the irritability of that organ would otherwise preclude its use.*

The solution of morphia generally used (for a knowledge of which I am indebted to my friend Mr. Flower) is one consisting of ten grains of the acetate of morphia to a drachm of distilled water; acetic acid being added in sufficient quantity to dissolve the salt; liquor potassæ is then added, drop by drop, until a slight film is produced, so that there may be no excess of acetic acid: from one-sixth to one-third of a grain of the salt is the usual dose, or from one to three minims of the solution.

If the general constitutional effects alone of the drug be required, it may be introduced into the subcutaneous tissue of the forearm, or at any other convenient spot; but if, as in the case of some neuralgiæ, a more local action is desirable, the injection may be made near the seat of pain. Whatever part be selected, the skin being pinched up between the forefinger and thumb, the tubular needle may be thrust in, and the solution injected.

Permanent counter-irritation may be maintained by means of the repeated application of blisters, each succeeding one being applied so soon as the one that preceded it has ceased to discharge. This plan seems to exercise a more decidedly counter-irritant effect; it is less irksome to the patient; and in chronic inflammatory affections of the joints, and analogous cases, it is an excellent substitute for some of the more formidable counter-irritants.

As a vesicant and general counter-irritant nitrate of silver has been most strongly recommended by Mr. Higginbottom; and to his interesting pamphlet on the subject the reader is referred for an elaborate account of its action, and its various applications to surgery.

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* In Mr. Lawrence's hands at St. Bartholomew's, in a case of delirium tremens, a dose of morphia introduced in this way speedily produced an effect which a larger quantity given by the mouth had failed to do in the same patient.

Acupuncture. This operation consists in the introduction of sharp-pointed needles into the subcutaneous tissue of the body; these are allowed to remain for a longer or shorter time, and are then withdrawn. Its chief use is in neuralgic affections, particularly those of the sciatic nerve, where it is employed for its counter-irritant effect. Its efficacy in certain obscure cases of painful muscular rigidity is highly spoken of by Dr. F. Ogier Ward, who recommends the insertion of the needles among the muscular fibres, retaining them there for some time. As a purely mechanical agent acupuncture is made use of to drain away œdematous effusions in the subcutaneous cellular tissue. The needles for this purpose are made short and strong, and fixed in cylindrical handles. They may be introduced by drilling through the skin with a rapid rotatory movement, effected between the forefinger and thumb of the right hand, the skin of the part being at the same time stretched between the fingers and thumb of the left hand; when the needle is withdrawn, the rotatory movement should be again adopted to facilitate its exit. Acupuncture is sometimes effected by percussion; the point of the needle being placed upon the skin, its handle is smartly struck so as to drive it suddenly through the integuments: lastly, the needle may be introduced with a sudden stabbing movement. In withdrawing the needle in either of the last-named methods, the skin on either side the puncture should be held down with the finger and thumb. Of the three plans the first seems to exercise the most decidedly counter-irritant effect.

Electro-puncture is nothing more than the application of a galvanic current to the tissues included between two acupuncture needles; these are introduced in the ordinary manner, and the negative and positive pole of the battery being connected respectively to one and the other of the needles, the current may be established between them. This form of counter-irritation is employed in the same description of cases as the acupuncture; its application, however, is far more painful; its chief use lies in the means which it affords of directly acting upon paralysed muscles.

Under the more permanent forms of counter-irritation are included (1) issues of various kinds; (2) setons; (3) the application of the actual cautery.

1. Issues are sores artificially produced, giving exit to a continued discharge; they are employed for local causes as counter-irritants; or for constitutional maladies, to establish a perpetual

drain on the system. When instituted for the latter purpose, some part of the body should be chosen where the subcutaneous cellular tissue is abundant, and also convenient by its position for subsequent dressing of the sore. Prominent points of bone and the neighbourhood of large veins, or cutaneous nerves, should be carefully avoided; the upper and outer part of the arm just below the insertion of the deltoid is the common spot selected for the formation of an issue; or on the lower extremity they may be conveniently placed on the inner side of the thigh, just above the knee-joint, and clear of the saphena vein. Though there is but little room for choice of situation when issues are applied for local purposes, yet the general rules that are mentioned above should, if possible, be observed.

Issues may be established by means of (*a*) various caustics, (*b*) the moxa, or (*c*) the use of the knife.

(*a*) For the formation of caustic issues, either caustic potash or Vienna paste is generally employed. To apply the caustic potash, a piece of plaster having a small hole cut in its centre, half the size of the intended issue, should be applied to the part to protect the surrounding skin; a bit of potash, the size of a small pea, may be placed over the hole in the plaster, and covered with a layer of soft lint; the whole may be retained in position by strapping, and should remain undisturbed until the caustic has exercised its full effect, that is, until it has destroyed the entire thickness of the skin; and this will generally take place in about four hours. On removing the application an ash-coloured central slough should be seen, surrounded by a bright halo of congestion: simple dressing or a poultice may be applied until the dead parts separate.* The size of the slough will generally be fully twice as large as that of the hole in the plaster; its depth will depend upon the quantity of the caustic employed. A more convenient method of applying the caustic potash is by mixing it with soap, in the proportion of three parts of the former to two of the latter; this diminishes the tendency of the potash to diffuse itself over the surrounding skin, and at the same time does not materially lessen its activity. *Vienna paste* is a mixture of five parts of caustic potash with six parts of quicklime. This compound possesses decided advantages over the caustic potash, in the greater rapidity of its action, and in being more easily confined to the spot to which it is applied. The powder should be made into the consistence of a paste by mixing it with alcohol; and being applied to the skin in the same manner and with the same precautions as the caustic potash, may be allowed to remain in contact for fifteen or twenty minutes, or longer if the integuments of the part are very dense. After the removal of the paste the parts may be gently washed with warm water, and simple dressing or a poultice applied until the slough separates.

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* Before applying the poultice, all remains of the caustic should be carefully removed, and this is best effected by sponging the part with a solution of acetic acid.

(*b*) The actual cautery in the form of the moxa, though generally employed for its immediate irritant effects, is not unfrequently made use of for the formation of issues; for this purpose it is preferred by some Surgeons as exercising a more decidedly counter-irritant effect, especially in certain affections of the joints, and in carious disease of the bones of the spinal column. The moxa is a tightly packed solid cylinder of cotton-wool, fitting into a metallic tube, open at both ends, and attached to a handle. The moxa being introduced into this tube, one end should be thoroughly ignited; and the opposite end being held in contact with the skin of the part, a continuous current of air should be maintained against its surface by means of a blowpipe, until the whole of the cotton-wool be consumed. Meantime the surrounding parts may be protected from injury by covering them with a thick layer of wet lint. The size of the eschar will be somewhat greater than that of the end of the metallic tube employed. Moxas may be prepared by soaking the cotton-wool in a strong solution of nitrate of potash, and subsequently drying them: in the application of these the use of the blowpipe may be dispensed with. The pain of the moxa is excessive during its application, but is not of long duration; the resulting slough is dry, dark-coloured, and cracked on its surface, and the surrounding integuments are brightly congested; the slough may be treated in the same manner as in other caustic issues. After the separation of the dead parts, the wound is generally allowed to granulate and heal up, but it may subsequently be treated as an ordinary issue.

(*c*) Issues are made with a knife by pinching up a fold of skin between the forefinger and thumb, rapidly transfixing it, and cutting it through, the cutting edge of the knife being turned upwards; or the integuments being put on the stretch, a crucial incision may be made extending into the subcutaneous tissue.

Having described the principal methods of forming issues, it now remains to allude briefly to the various plans adopted for keeping them open. So soon as the eschar separates in the case of the caustic issues, and at the time of their formation when the knife is used, one or more glass beads or issue-peas may be applied to the surface of the sore, and there retained in firm contact with the parts by means of strapping for four or five days. When suppuration is fully established, the wound should be cleansed daily, the peas being removed and replaced at each dressing; should the granulations become too exuberant, they may be touched occasionally with nitrate of silver. To prevent the wound healing, it is occasionally necessary to reapply the caustic potash or Vienna paste; but a more convenient and less painful method of effecting the same purpose is to dress the surface from time to time with the *papier épispastique*, or the issue-peas may be occasionally smeared with some irritating ointment.

Of the various methods employed for establishing issues, that by means of the moxa is the most decided in its counter-irritant properties; its effects are produced more quickly, and the issue thus formed can be kept discharging for a longer period than any other; at the same time this plan is exceedingly painful in its application. Issues formed by caustic potash or Vienna paste rank next for efficacy and permanency; while those formed by means of the knife are both difficult to keep open and more scanty in their secretion than others, though they have the advantage of causing but little pain in their application.

Setons. A seton is an artificially-produced sinus, through the track of which some material is passed to excite suppuration, and to maintain the patency of its orifices. They are established in the subcutaneous tissue of the body, (*a*) as counter-irritants, or (*b*) to act as continued sources of drain on the system. As local irritants, they are passed through various cavities to excite inflammation and procure adhesion of the opposite surfaces; or again, they are used as means of gradually evacuating the contents of cysts, chronic abscesses, and other abnormal cavities. For the purposes of counter-irritation, setons are generally inserted in the neighbourhood of the part affected; as for instance, in front or behind the ear in certain chronic affections of the eye, or over the pubes in certain diseases of the bladder. But when employed to act as drains on the system at large, the nape of the neck is the part generally selected for their insertion. To establish a seton in the subcutaneous tissue, a fold of skin should be grasped and raised from the deeper structures; this should be transfixed at its base by the instrument carrying the seton rather obliquely, so that one of the openings in the skin shall be more dependent in position than the other. The size of the fold of skin to be transfixed will depend upon the length of the seton; but in all cases the needle must pass deeply through the subcutaneous tissue, and not immediately beneath the skin, or the latter will slough over the whole track of the wound. On the nape of the neck a longitudinal fold of skin over the spines of the cervical vertebræ is generally raised and transfixed nearly at right angles to the axis of the spine. The instruments used vary with the material of which the seton is to be composed; thus, ordinary needles of various sizes are employed when one or more silken or wire threads are to be introduced, whereas if a gum elastic band is used to keep the wound open, a properly adapted seton-needle should be employed; though in the absence of this, the parts may be transfixed with a double-edged bistoury, which will also serve as a guide for the introduction of the seton.

Whatever material is employed to keep the wound open and excite discharge, it should first be smeared with oil; and having been introduced, may be allowed to remain undisturbed for four or five days, or until suppuration is fairly established; subsequently the dressing may be changed daily, and the seton be pulled on each occasion a little farther through the wound, care being taken to oil that part of it which is to occupy the wound, before moving it. If the seton be composed of silken or other threads, when it is nearly all pulled through the wound, a fresh piece of the same material may be attached to its end, and thus drawn into the sinus. Gutta-percha or gum elastic bands need only to be shifted each day one way or the other, the projecting ends being carefully wiped, so that the discharge does not accumulate and harden upon them. In the subsequent progress of the case it may be occasionally necessary to smear the ends of the seton with some irritating ointment to produce a more copious discharge from the wound.

For exciting local inflammation and adhesion the seton is employed in the treatment of hydrocele, enlarged bursæ, ranula, and elsewhere. For such a purpose, a single thread, or better, a silver wire, is passed through the cavity with an ordinary needle; or if the cyst be large, a needle fixed in a handle, and having an eye at its point, may be used. A needle has recently been invented by M. Matthieu, of Paris, having an eye at the point, which latter dislocates at pleasure: this needle, besides its special use in vesico-vaginal fistula and rupture of the perinæum, is admirably adapted for passing a wire through the tunica vaginalis in hydrocele, or through any cavity of considerable extent.

Setons are nowadays but rarely employed for emptying large cysts or chronic abscesses, their use for this purpose having been superseded by the drainage-tube of M. Chassaignac.

The *actual cautery* is some metallic substance raised to an elevated temperature, and applied to the tissues of the body; steel or iron are the only metals now employed for this purpose. This form of cautery is made use of for arresting hæmorrhage, for destroying diseased surfaces and morbid growths, and for exciting counter-irritation of almost every degree, from simple rubefaction up to complete destruction of the skin and subcutaneous tissue.

Cauteries are made of steel, fixed in wooden handles; their heads or extremities are of various shapes, being bulbous, conical, hatchet-shaped, or hammer-headed, varying with the special purpose or part of the body to which they are applied. They may be heated in an ordinary fire, or by means of a spirit-lamp. Three degrees of temperature are generally recognised, namely, white heat, red heat, and an inferior degree when the metal is black, or as hot as it can be without losing its natural colour. As a general rule, the hotter the metal is at the time of application, the less pain will it produce.

In making use of the actual cautery to a raw surface, whether for the suppression of hæmorrhage or for other purposes, the surface should first be carefully dried; the iron, flat-headed or conical in shape, may then be applied to the part with a light hand, being kept in motion, or at all events not allowed to remain in contact with any one part of the wound for more than a second or two, otherwise the disorganised tissues will stick to the metal, causing great pain, and often considerable hæmorrhage when the instrument is removed. When the hot iron is applied to the sound skin for its counter-irritant effects, a hatchet-shaped cautery is generally employed; the thin edge of this may be drawn rapidly and lightly over the surface in parallel lines an inch or more apart. There are certain parts of the body to which this remedial measure should not be applied; these may be stated to be the immediate neighbourhood of subcutaneous bones, such as the vault of the skull and the sternum; salient points of bone, as the acromion, olecranon, patella; the course of the larynx or trachea; superficial tendons, and the neighbourhood of such synovial membranes as lie very near the surface. The effect of the heated iron may be varied in degree by holding it at a greater or less distance from the skin. Its indirect application is thus employed by many Continental Surgeons as a stimulant to ulcers or unhealthy wounds; the cautery being held first at some distance from the part, and being gradually approximated until the surface of the sore is covered with a thin dry scab.

For the destruction of morbid growths or cancerous ulcers, the actual cautery may be retained in contact with the diseased tissues, or freshly-heated cauteries be frequently renewed until complete charring of the parts has been effected.

Bloodletting.

For the convenience of description, this remedial measure may be considered first in its local, and secondly in its general application. In local bloodletting the blood is drawn from the capillaries; this may be effected by leeching, scarification, or cupping. General bloodletting includes venesection and arteriotomy.

Leeching. Leeches should be removed from water an hour or two before their application, and, having been carefully dried in a clean cloth, they may be applied to the skin of the part, after it has been carefully cleansed, freed from hair, if that exist in any quantity, and, if need be, smeared with a little milk to induce the leeches to bite. If the blood is to be abstracted from the external surface of the body, the leeches may be conveniently covered with an inverted tumbler or wine-glass until they have attached themselves; or they may be placed in the hollow of a large and loosely made pad of cotton-wool covered with lint; or a clean towel may be folded so as to contain them, and being inverted over the part, may be maintained in position by gentle pressure. Again, two or three may be placed together in an open pill-box, which must be inverted and maintained in contact with the part. When it is desirable more exactly to localise the point of application, as in leeching the gums, eyelid, or lacrymal sac, the leech can be retained in position, until it has attached itself, by means of a leech-glass, or a card rolled up in a cylindrical shape. When there are but few leeches to be applied to the external surface of the body, each may be held singly between the forefinger and thumb, while its mouth is directed to the part to which it is intended it should attach itself. There are certain parts of the body where particular precautions should be adopted in abstracting blood by this means. To the eyelid, nasal mucous membrane, lacrymal sac, and cavity of the mouth, a leech-glass or rolled card ought always to be used. In leeching the eyelid, the patient should be placed in the recumbent position, and should thus remain for some time; this will generally obviate the unsightly ecchymosis which is apt to occur in the loose cellular tissue of the part.* Leeches may be applied to the os uteri by first introducing a speculum, thus protecting the vagina, and leaving the os uteri free and projecting into the cavity of the instrument; they may then be pushed down the speculum, and maintained in contact with the os by means of a pledget of cotton-wool until they have attached themselves.

A healthy leech will draw about ʒij. of blood, and this quantity may be increased by subsequent fomentation of the bite to about ℥ss. It is said that the capacity for abstracting blood may be largely increased in leeches by making minute punctures on their dorsal surface, just above the caudal extremity; of course this proceeding cannot be adopted until the leech is firmly attached and well distended with blood; it is a measure, one would think, of very equivocal advantage. When leeches, though fully distended, still remain attached to the surface, the popular applications of salt or snuff to their bodies will generally induce them to relax their hold.

To obtain a further flow of blood from the bites after the separation of the leeches, warm linseed poultices or fomentation with warm flannels are generally employed, or the part, if on one of the extremities of the body, may be immersed in warm water. When it is desirable to arrest the hæmorrhage at once, the bites may be freely exposed to the air, or the part being covered with lint or a dry cloth, pressure over it may be made with the hand, or maintained by a bandage; should this be insufficient, a little shredded lint being placed over each bite, firm pressure may be made with the finger-ends; or again, the bleeding points may be touched with nitrate of silver or perchloride of iron. In cases where the hæmorrhage is alarming, or the foregoing means have failed to arrest it, the soft parts beneath the bite may be transfixed by a fine needle, and a silk ligature may be wound around them beneath the needle-ends. In selecting a spot for the application of leeches, it may not be amiss to bear in mind the fact of the characteristic triradiate cicatrix left by the bite, and that this is indelible.

Scarification is employed in various parts of the body, as a means of directly relieving the local congestions of free surfaces. The operation consists in making small incisions on the surface of the part with the point of a lancet or scalpel; these incisions varying in depth and extent with the texture of the part affected and the severity of the local mischief. They are employed in chemosis of the conjunctiva, phlegmonous inflammation of the integuments, acute engorgements of the tongue and tonsils, and in other parts.

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* Leeches should not be applied to the upper eyelid.

Cupping in its most ordinary form consists in the local abstraction of blood from minute incisions by means of atmospheric pressure; cupping-glasses, a scarificator, and a spirit-lamp, are required for the performance of this operation. Cupping-glasses are of various forms and sizes, but, for the most part, narrow at their necks and somewhat dilated at the opposite extremity. They are employed for creating a partial vacuum over that part of the surface from which the blood is abstracted; the air within them is rarefied by introducing for a second or two the flame of a spirit-lamp; on the withdrawal of this, the open mouth of the glass is immediately applied to the part to be cupped. This has the effect of producing great local congestion and swelling up of the parts included within the rim of the glass. The glass may be conveniently removed by tilting it to one side, and at the same time insinuating the point of the forefinger under its edge on the opposite side. The *scarificator* is used for simultaneously and quickly effecting the necessary incisions for the abstraction of blood; it is formed of a number of blades fixed on an axis, which latter by a rapid semirotatory movement projects the blades through appropriate openings in the instrument, and divides the integument to the required depth. Before its application the blades of the scarificator should be set so as to cut through the cutis vera, but not to encroach upon the subcutaneous tissue; this being effected, the spring may be drawn back, and set, and the instrument being held pretty firmly in contact with the skin, the spring may be released.

Before the application of cupping-glasses the skin of the part should be sponged with warm water, and any hair there may be on the surface should be removed; a basin of warm water and a lighted candle should be at hand. The glasses being first placed in the warm water, should be applied, in the manner above mentioned, one by one to the part from which the blood is to be drawn; care being taken that sufficient intervals are left between the glasses: they may be allowed to remain in contact with the skin for about a minute; as each is withdrawn, the scarificator should be applied to the swollen integument beneath, and the glass should be as quickly as possible readjusted to the part. The blood will continue to flow from the incisions until the exhaustive power of the glass has ceased by the vacuum within being destroyed; when this occurs, the glass may be removed, and a fresh one may be applied to the same spot, the surface being first sponged to remove any coagula that may have formed. As each glass is removed, the blood from it may be emptied into a graduated vessel. When the required amount has been abstracted, the wounds may be sponged, dried, and each group covered with a piece of diachylon plaster.

It is often extremely difficult to procure the required amount of blood by means of cupping; and this, though it may occur from many causes, is chiefly owing to one of two reasons, namely, that either the depth of the incisions has not been rightly adapted to the thickness of the skin of the part, or that the vacuum within the glass is insufficient or too complete. To avoid both these evils requires some knowledge of the different thickness of the integument on various parts of the body, and a certain manual skill which can only be acquired by practice. When the skin has been too freely divided by the scarificator, the subcutaneous tissue is apt to bulge through the incisions in the skin and hinder the flow of blood, while the disadvantages of an insufficient division are obvious. Should the atmospheric pressure be so great as to constrict the cutaneous capillaries around the rim of the glass, this pressure may be relieved by rotating the glass a little, or by swaying it to and fro, so as to allow a little external air to get beneath its margin.

There remains to speak of another form of cupping, usually termed "dry cupping." The object of this is to abstract blood temporarily from one part of the body by detaining it for a time in other parts. To effect this, several cupping-glasses are applied and renewed at intervals, their position being slightly varied each time, so that the skin may not suffer from the pressure.

As a general rule cupping-glasses should not be applied in the immediate neighbourhood of inflamed tissues, nor over the mammary region. Their adjustment also is well-nigh impossible in certain situations, such as the perinæum, or the anterior regions of the thorax in emaciated patients.

M. Junot has devised an instrument by which he considers that he produces a transient condition of general depletion. The apparatus consists of a metallic cylinder closed at one extremity, and sufficiently large to contain either the upper or lower limb; attached to the cylinder is a small stop-cock, to which is fitted an exhausting syringe. One of the limbs is immersed in the metallic case, and a very wide india-rubber band being drawn over the open end and around the limb, so as to form an air-tight cavity, the syringe is applied until the condition of the pulse indicates that a sufficient amount of air has been removed. This proceeding is said to possess many of the advantages of general depletion without exercising any permanently debilitating effect on the constitution.*

General Bloodletting.

Venesection. This operation may be performed upon the veins of the forearm or hand, the external jugular, the veins beneath the tongue, those of the scrotum, and the internal saphena, near the inner ankle. Whatever vein is opened, it is necessary, when practicable, to produce congestion of it, by compressing the vessel between the point to be opened and the heart. A lancet, bleeding-tape or a narrow bandage, lint, a bowl to receive the blood, and a basin of water and a sponge, are required. The operation, as ordinarily performed in this country, consists in opening one of the veins at the bend of the elbow. Of these the most prominent are the median cephalic and the median basilic, the former being situated to the outer side of the tendon of the biceps, the latter to its inner side, and immediately over the course of the brachial artery, indeed only separated from the artery by the fascial attachment of the biceps muscle. For anatomical reasons, therefore, the median cephalic should be preferred for venesection; but in practice the more prominent and larger vein of the two is selected.

The patient being placed in the sitting posture, the bleeding-tape or bandage may be tied around the limb about the middle of the upper arm, sufficiently tight to arrest the venous circulation without affecting the pulse at the wrist. The forearm having been allowed to hang down until the veins are tense and turgid, the operator may select one for his purpose, and taking the blade of the lancet between the forefinger and thumb of his right hand, should fix the vein by pressing his left thumb upon it, just below the part he is about to open. Steadying his hand by resting the ends of the three inner fingers on the forearm, the point of the lancet may be introduced obliquely until the interior of the vein is reached and the blood rises up out of the wound; without penetrating any deeper, the lancet should now be thrust onwards, thus laying open the vein longitudinally, and cutting its way out in advance of the point of puncture. The vein being well opened, the thumb may be removed, and the blood allowed to flow; if the stream be scanty and sluggish, the ordinary expedient may be adopted, of directing the patient to clench his fist firmly from time to time, or the Surgeon may chafe the veins on the palmar surface of the forearm, rubbing from below upward. When the required amount of blood has been abstracted, the thumb of the left hand may be placed over the wound, and the ligature around the arm relaxed; a small pad of lint being placed over the orifice in the vein, the parts around should be cleansed from blood, and the tape applied in a figure-of-eight fashion, so that the crossing of the tape lies over the pad on the vein and keeps it in place, exercising pretty firm pressure (fig. 2, p. 4). From a want of coincidence between the wound in the integuments and that in the coats of the vein, the blood may cease to flow altogether, or may continue to escape in a diminished stream; this is frequently caused by the wound having been made while the arm was in the supine position, and by the subsequent pronation of the limb; it can generally be remedied by sliding the skin over the vein until the two wounds are made to coincide. In extreme cases of this kind, where the blood escapes into the surrounding cellular tissue, the swelling occurs to which the term thrombus is generally applied. This, if of considerable size, may be laid open with the lancet, though more generally it needs no surgical interference, but may be allowed to become absorbed. After the operation, the arm should be carried for a day or two in a sling.

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* In a case in which I had an opportunity of observing its effects, these were less marked in the constitution at large than in the limb itself; the latter seemed intensely congested, and on the removal of the instrument, was covered with minute cutaneous ecchymoses.

In children, and occasionally in others, where the subcutaneous veins at the bend of the elbow are ill-defined or of small size, venesection is practised on the external jugular. For this a pretty bulky pad of lint is required; it should be applied over the vein in the hollow just above the clavicle and external to the sterno-mastoid muscle, and should be secured by a bandage passed over it and fastened in the opposite axilla, so as to exercise firm pressure on the vein. The part of the vessel generally chosen for the operation is where it overlies and crosses the sterno-mastoid; the vein being fixed with the thumb of the left hand, the incision may be made in the same manner as in bleeding at the bend of the elbow, the line of the wound being parallel to the fibres of the sterno-mastoid muscle, so as to secure a transverse division of the platysma myoides. The blood can be directed into a bowl by means of a piece of card-board folded in the form of a gutter, or it may be collected in a teacup held close below the wound. To arrest the bleeding, a pad must be applied over the wound, and retained by strips of plaster; the compress over the clavicle may then be removed. The possibility and the effect of the entrance of air into the vein during the foregoing operation, is too well known to require more than a passing caution, to see that the pad applied to the vein is thoroughly effectual in arresting the circulation, and to be careful not to remove this pad until after the orifice in the vein has been closed.

The saphena vein is but rarely opened for the purposes of venesection; in this country at least, though there are many Continental Surgeons who consider it a more favourable vessel for the operation than the veins at the bend of the elbow. The venous current is in this case arrested by a bandage around the limb, just above the ankle; the vein is opened above the inner malleolus, and the bleeding is encouraged by immersing the foot in warm water.

The cutaneous veins of the scrotum may be advantageously opened in many cases of acute orchitis, the bleeding being encouraged by warm fomentations, and arrested when necessary by exposing the part to the external air or by the application of cold water. For the various mishaps and ill consequences of venesection and their appropriate treatment, the reader is referred to the essays on INJURIES AND DISEASES OF THE VEINS AND ARTERIES.

Arteriotomy. The only vessel on which this operation is practised is the temporal artery itself, or one of its principal branches; the main trunk of the vessel may be found crossing the zygoma at right angles about half an inch in front of the pinna of the ear, and just above this spot the artery divides into its anterior and posterior branch. A small bistoury or a lancet, a narrow bandage, a small firm compress, sponge and water, and a bleeding-bowl, are required for this operation. The position of the anterior division of the vessel being ascertained, or that of the main trunk itself if the former be of insufficient size, its exact situation should be marked, and the vessel may be at the same time fixed by placing the forefinger or thumb upon it, just below the point where it is to be opened. The blood should be drawn from a transverse wound in the vessel, made by cutting down upon it with a bistoury; or with a lancet, by first puncturing its coats and then laying open its canal more freely. To arrest the hæmorrhage the artery may be completely divided, the part sponged, the compress applied to the wound and secured by the knotted form of bandage (fig. 4, p. 6). This should be most carefully adjusted, so that it may remain undisturbed for four or five days, when it may be removed, and the wound covered with a strip or two of plaster.

VACCINATION.

In addition to the common lancets and ivory points, there are special instruments constructed for introducing vaccine lymph. Mr. Seeley of Aylesbury has invented a small arrowhead-shaped lancet, with a groove on one of its flat sides, for carrying the lymph. A small needle, grooved up to its point, is also made use of by others. A needle with an arrowhead-shaped point has been invented by Mr. Sprattey; this has a groove on one surface, and a small rectangular shoulder about a twelfth of an inch from the point. This instrument is fixed in a hollow ivory handle, within which capillary tubes containing lymph can be carried. Dr. Husband uses an instrument invented by Dr. Weir, having a flat ivory handle fitted with a lancet at one end, and at the other four minute needle-points; by drawing these sharply over the surface, the cutis is slightly abraded; two such scratches are made, and over these the lymph is gently rubbed. These scratches should be quite an inch apart, since lymph applied in this manner generally produces a group of confluent pustules. Vaccine lymph should be taken from the vesicle not later than the eighth day after inoculation. When fresh virus is to be applied directly from a mature vesicle, the patient's left arm should be grasped in the operator's left hand, just above the insertion of the deltoid muscle, and the skin on the outer aspect of the part put on the stretch. The lancet, being previously armed with the vaccine lymph, is held with the flat of its blade turned towards the surface, and is made to perforate the cuticle very obliquely, so that its point may separate the cuticle from the cutis to a small extent; this may be effected without causing any hæmorrhage, or at most, not more than a drop of blood need escape. As it is withdrawn, the lancet may be pressed against the raw surface of the cutis, or the thumb of the left hand may be used to press the edges of the puncture together, so as to wipe the virus off the point; two or three such punctures should be made, each about an inch distant from the other, and any blood or serum exuding from them should bo allowed to dry on the part.

Ivory points or slips of quill may be used to dip in the virus, and insert into punctures, instead of employing the lancet for this purpose. If dry lymph upon points be used, it must first be softened over the steam of hot water, or it may be moistened with warm water before its introduction; lymph between glass slides should be moistened and scraped off the glass with the lancet-point, and thus applied. A very efficient but more painful method of vaccination is the plan of scratching off the cuticle with the lancet-point, and applying the virus to the denuded cutis.

Dr. William Husband, of Edinburgh,* has introduced and established a method by which vaccine lymph may be preserved for considerable periods of time, uninfluenced by changes of climate. This he effects by hermetically sealing it within capillary glass tubes; he recommends for this purpose such as are from two to four inches in length, and about $\frac{1}{28}$th of an inch in diameter, their walls being $\frac{1}{200}$th of an inch in thickness. The following are the directions given by Dr. Husband for charging these tubes.

The vesicles having been opened with the lancet in the usual way, the tube, held horizontally, is charged by applying one end of it (the straight end if they be not both straight, not that which tapers to a point) to the exuding lymph, which enters immediately. As much lymph is allowed to enter as will fill from about one-seventh to one-half the length of the tube. As a general rule, each tube should not be charged with more than will suffice for one vaccination. It may be sealed in one or other of the following ways. In the first, the lymph is made to gravitate towards the middle, by holding the tube vertically, and if necessary giving it a few slight shocks by striking the wrist on the arm or table. The end by which the lymph entered may then be sealed, by applying it to the surface of the flame of a candle. The other end should first be plunged about half an inch into the flame, and as quickly withdrawn till it touches the surface, where it should be held till it melts over and is sealed. This precaution, of plunging the tube into the flame before sealing it, is useful, in order to expel a portion of the air. Or the tube may be sealed thus: the lymph having been introduced at one end of the tube, is made to pass towards the opposite by exhausting the air at that end over the flame of a spirit-lamp; this end of the tube is then sealed. On cooling, the lymph will pass towards the middle of the tube; the orifice by which the lymph entered is then sealed, as in the first method. Not more than a minute or two should elapse between charging the tube with lymph and sealing it up, or the lymph will concrete at the orifice, and cannot then be forced into the centre of the tube.

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* *Exposition of a Method of Preserving Vaccine Lymph fluid and active; with Hints for the more efficient Performance of Public Vaccination.* London, Churchill, 1859.

In order to obtain the lymph from a tube for the purpose of vaccination, the sealed ends are to be broken off, and the fluid contents blown out gently on the point of the lancet or vaccinating instrument.

The result of primary successful vaccination may be stated to be as follows:* the puncture may be felt slightly elevated on the second day; on the third it is surrounded by a slight halo of redness; by the fifth a distinct vesicle will be formed, having a slightly elevated margin and a depressed centre; on the eighth day the vesicle should have reached its perfect condition, when it is pearl-coloured, and distended with clear lymph, its margin being turgid, firm, and shining. From this period the redness around increases in extent and intensity until the tenth day, when there is often well-marked swelling, and induration of the subjacent cellular tissue. On the eleventh day the areola begins to subside, leaving as it fades two or three concentric rings of redness; the vesicle begins to dry up, assuming a brownish colour; the remaining lymph becomes opaque, and gradually concretes, forming by the fourteenth or fifteenth day a dry reddish-brown scab; this contracts, dries, blackens, and finally falls off about the twenty-first day. The resulting cicatrix is permanent, slightly depressed, dotted or minutely pitted.

When persons who have once been successfully vaccinated are some years afterwards re-vaccinated with effective lymph, vesicles occasionally result, which in their appearance and in the course they run cannot be distinguished from those produced by primary vaccination. Far more generally these results are variously modified; either no true vesicle forms, or it attains its maturity and runs its course with greater rapidity than the regular vesicle. The areolæ also tend to diffuse themselves more widely and less regularly than in primary vaccination, and the local changes are accompanied by much itching, often by some irritation of the axillary glands, and in some cases by considerable febrile disturbance supervening on the fourth or fifth day.

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* This description is taken from the account given in the instructions to public vaccinators by order of the Privy Council.

CAUSTICS.

The various substances used for destroying morbid growths or the tissues of the body by chemical agency are generally termed potential cauteries. They will briefly be noticed in order, according to the degree in which they exercise their disorganising effects. And, firstly, those substances which either from their want of caustic power or from the tardiness of their action are generally applied only to raw surfaces, though occasionally to mucous membranes. These are such as tannic acid, sulphate of copper, nitrate of silver, sulphate of zinc, acid nitrate of mercury, arsenical paste, the chlorides of antimony and of zinc.

Tannic acid, as a caustic agent, is but rarely used in surgery; applied in the form of powder to raw surfaces, it produces a thin layer of disorganised tissue.

Sulphate of copper exercises sufficient caustic activity to be employed for the destruction of warts and condylomata, of fungous and unhealthy granulations, or the secreting surfaces of cysts. To produce any considerable effect, the solid salt requires to be rubbed pretty firmly over the part to be cauterised, the surface being previously moistened if dry.

Nitrate of silver, as a caustic, is applied in a solid form or in a saturated solution; it is chiefly of use in checking exuberant granulations, in destroying the surfaces of unhealthy ulcers or secreting cysts, in stimulating flagging sores, in producing a superficial slough on the surface of poisoned wounds, thereby diminishing their absorbent power, or for destroying warts and small condylomatous growths. In the solid form this salt is applied either by lightly brushing it over the part, producing a thin scale of dead tissue, of a bluish-white colour, turning to black; or by rubbing it firmly again and again over the surface, so as thoroughly to destroy the part to a more considerable depth. Dry surfaces should be slightly moistened, and very moist or suppurating surfaces require to be partially dried before this caustic is used. In solution nitrate of silver is applied with a camel's-hair brush or a small piece of sponge, the caustic effect being far less marked than when used in the solid form. Though possessing but limited power compared with many other substances, yet lunar caustic has the advantages of acting with great rapidity, of causing but little pain, and of producing but slight irritation or disturbance in the surrounding tissues.

Sulphate of zinc. The introduction of this substance as a caustic is due to Dr. Simpson of Edinburgh, who recommends its use either in the form of finely levigated powder, as a paste composed of one drachm of glycerine rubbed up with an ounce of the powder, or as an ointment made in the proportion of two drachms of lard to an ounce of the dried sulphate.

It is applicable to ulcerations of the os uteri, rodent and lupous sores, or indeed to almost any form of obstinate or inveterate ulceration. For destroying warts and condylomata, and the vascular growths about the female urethra, it is said to be most efficacious. Dr. Simpson states that used in the form of powder, paste, or ointment to an open or ulcerated surface, it quickly produces a slough corresponding in depth to the thickness of the superimposed layer of caustic. The slough is of a white colour, and usually separates about the fifth day, leaving behind it (if the whole morbid tissue be removed) a red granulating, healthy, and rapidly cicatrising wound. The disorganised tissues show no tendency to decompose, but are firm and inodorous. This caustic will only act on ulcerated or abraded surfaces; where the epithelium therefore is entire, the part must be prepared for its application by the previous use of the nitric acid or some other of the stronger caustics. The pain produced by the sulphate of zinc is said to be less enduring than that caused by caustics generally, the local inflammation is very slight, and the eschar has been observed to separate in most cases about the fifth or sixth day. Among other advantages claimed for this substance by its distinguished inventor, are the facility with which it is applied, the rapidity of its action, and the certainty with which its effects can be localised, since it shows no tendency to deliquesce; nor does its disorganising power exert any influence over the surrounding surface, provided the epithelial covering is entire.

Acid nitrate of mercury is a fluid form of caustic, owing its activity to the nitric acid in its composition; though less powerfully caustic than that acid, it is better fitted for application to certain parts since it does not fume when exposed to the air. It is much in use for the destruction of lupous and rodent ulcers, and for the former of these it is a most convenient and efficacious application. The solution is best applied with a camel's-hair brush, the surface of the part being previously cleansed and dried: it is necessary to limit carefully the application to the diseased part, since the epithelial covering of the mucous or cutaneous surface affords an insufficient protection against the action of this caustic. It may be well to mention that cases of poisoning are recorded from the absorption of this substance applied as a caustic.

Arsenical paste. The only active ingredient of this preparation is arsenious acid; this is diluted with various inert substances to the required extent. The arsenical paste most in use in this country is that first employed by Baron Dupuytren; it consists of a mixture of calomel and white arsenic, in the proportion of from six to ten parts, by weight, of the latter to a hundred of the former. This being made into a paste with mucilage or a little water may be applied to the surface of the parts either directly or spread on lint or a piece of blotting-paper. The efficacy of this caustic is undoubted in the treatment of lupous, rodent, and other intractable ulcers; but there exists the obvious objection to its use, that it cannot be employed on a surface of any considerable extent, on account of the danger of its absorption into the system. Indeed a case is related in the practice of M. Roux where the application during a single night of a paste, containing four per cent of arsenic, to a surface of little more than an inch in diameter proved fatal. Considerable and sometimes enduring pain follows its use, accompanied with no little irritation and inflammation of the surrounding parts, and the eschar is slow to separate. The arsenical paste is inert on surfaces protected by epithelium.

Terchloride of antimony, or butter of antimony as it is usually termed, is a substance possessing powerful caustic properties, though but little used in this country at the present day.

Butter of antimony is stated by Pereira to consist of a solution of the terchloride of the salt in hydrochloric acid; it is used for the destruction of syphilitic warts or condylomatous growths, and is recommended by Continental Surgeons for application to poisoned wounds and the bites of rabid animals. The solution may be applied with a camel's-hair brush until a whitish slough is produced, when the surface of the part should be thoroughly washed to remove any remaining caustic.

Chloride of zinc forms the active ingredient of many of the most popular and effective caustics; mixed with variable proportions of flour it constitutes Canquoin's paste. It enters into the formation of Landolphi's caustic, combined with equal parts of the chlorides of antimony, bromine, and gold. More recently other adventurers have made use of the caustic properties of this salt, and by mixing it with pretended remedies for cancer have endeavoured to impose on the public, and conceal the complete uselessness of their suppositious specifics.

Chloride of zinc may be used in the form of solution by mixing one part of Sir W. Burnett's solution with seven parts of water, or as a paste in the proportion of one part of the dry chloride to two, three, or four parts of flour or plaster of Paris.* It is employed to destroy ulcerated surfaces, or to remove solid growths of various kinds: it should not be applied to any but an ulcerated, abraded, or denuded surface, as its action upon the parts protected by their epithelial covering is both slow and extremely painful. The solution may be applied on pieces of lint cut rather smaller in extent than the intended slough. The paste may be spread on lint in a layer varying in thickness with the depth of the part to be destroyed; in mixing the paste, the chloride will generally absorb sufficient moisture from the atmosphere to render the addition of spirit unnecessary. This caustic takes some hours to produce its full effect; the pain it produces is considerable, but not so acute or enduring as that caused by arsenical paste.

The slough when formed is whitish, dry, and inodorous; there is little inflammation excited in surrounding tissues; and decomposition in the wound, if it previously existed, is at once arrested. Nor does the slough itself show any tendency to putrefy. A considerable advantage attached to the use of this caustic is the very contractile nature of the wound resulting from its application, a contractility which becomes evident some days even before the separation of the slough.

In attacking solid growths with the chloride, to save time in the subsequent progress of the case, it is usual after the first application, and so soon as the slough is fully formed, to make incisions through the dead parts; these being stuffed with shreds of lint dipped in the caustic solution, or smeared with the paste, may from time to time be deepened until the whole substance of the growth is destroyed.

Nitric, hydrochloric, and sulphuric acid, in a concentrated form, are the most powerful of the potential cauteries; their influence extends rapidly through the common integument of the body to the deeper textures; they will act upon any part of the surface to which they may be applied. In the liquid form no caustic is so suitable as one or other of the above named for destroying the surface of sloughing sores, or for the local treatment of hospital gangrene. Their effect on such a surface is decided, rapid, and, in the case of the monohydrated nitric acid, far less painful than is generally supposed: the resulting eschar separates quickly, and the surrounding inflammation is not excessive. In applying the strong acid to a sore, the surface of the part should be carefully dried, and the skin in the neighbourhood protected by being smeared with oil or simple cerate; and a glass brush, or a piece of cotton-wool or lint tied on the end of a piece of wood, may be used to bring the acid in contact with the surface of the sore.

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* This caustic, either in solution or in its solid forms, may be advantageously mixed with the hydrochlorate of morphia, which in a measure diminishes the pain attending the application.

For application to the sound skin, the concentrated acids are somewhat too diffuse in their action: with a view to obviate this tendency, they are mixed with various inert substances, and made into the consistence of a paste; thus sulphuric acid is mixed with powdered sulphur, saffron, or sawdust, and in this form it is far more convenient and manageable for the purpose above mentioned. The use of sawdust for this purpose originated with Mr. Syme, who also devised a most ingenious plan for protecting the surrounding surface, a method that can be adopted with great advantage whenever caustic is applied to the unbroken skin.

Mr. Syme gives the following account of the method in question: "A solution of gutta-percha in chloroform is applied to the skin for some distance around the parts to be attacked; then a thick piece of the same material, with an aperture cut in it the requisite size, and softened by exposure to heat, is pressed firmly so as to adhere to the surface thus prepared; a thin piece is next glued around the edge of the opening, so that when supported by a stuffing of lint it may form a wall enclosing the diseased part. Concentrated sulphuric acid, with about an equal weight of sawdust stirred into it, until the mixture assumes a homogeneous consistence equal to that of thin porridge, is lastly applied, in quantity proportioned to the extent of thickness concerned."

In the course of ten or twelve hours a slough will have formed, presenting the "appearance of strongly compressed tow."

For destroying the integuments, or denuding the surface preparatory to the use of some of the less active forms of caustic, Mr. Syme's mixture of sawdust and acid is specially adapted, or the caustic potash may be employed in the same way. Caustic potash, however, has the disadvantage of diffusing itself rapidly among surrounding parts; for this reason, with a view to confine its action, it is generally mixed with quick-lime in the proportion of five of the former to six of the latter, forming the Vienna paste, a more manageable and more active preparation than the pure potash.

Cautérisation en flèches. In 1858 M. Maisonneuve drew the attention of the Académie des Sciences to a method of applying caustic for the destruction or enucleation of solid growths, and gave to his method the name at the heading of this paragraph. The caustic he employs for this purpose is a mixture of one part of chloride of zinc and three of flour, combined so as to form a thick paste. This being spread out into a flat cake, is cut into narrow lancet-shaped strips, or wedge-shaped pieces, of a suitable size; these are subsequently dried until they acquire sufficient consistence to be available for the purpose about to be described.

One plan of attacking a solid growth with this form of caustic is the following: the base of the tumour is surrounded at short intervals by radiating punctures, converging towards the centre and deepest part of the growth, and completely undermining the diseased tissues; these punctures are made with a double-edged scalpel, the flat of the blade being turned towards the surface of the surrounding skin, and each should be of sufficient size to admit of the introduction of one of the caustic arrows previously prepared; as each puncture is made, the caustic should be at once plunged into the track of the knife, and allowed to remain. In a period varying from ten to twenty days, the whole growth will generally separate, leaving a clean granulating wound.

In cases where the growth cannot be circumscribed in the manner above mentioned, but can only be approached from the surface, M. Maisonneuve plunges the "flèches" in parallel lines into all parts of the substance of the tumour; or again, when it is important to preserve the skin over the site of a tumour, one or more of the "flèches" may be introduced through a lateral puncture quite into the centre of the growth, the resulting slough being allowed to escape through the aperture of puncture.

As a more convenient and more ready form of caustic, Mr. Paget has recently made use of small lancet-shaped slips of wood dipped in fused chloride of zinc; these are more readily prepared, and far more easily introduced, than the flèches recommended by M. Maisonneuve. It is needless to do more than to remark that this plan of removing tumours by enucleation, which can only be required in exceptional cases, is an exceedingly painful process.

The actual cautery has already been alluded to in the consideration of counter-irritants: in its ordinary form it is but rarely used for other than its counter-irritant or styptic effects; but as the galvanic cautery, there are many and various purposes for which it may be advantageously employed.

The galvanic cautery. This country is indebted to Mr. Marshall for the application of this most commodious and ingenious form of cautery; more recently Dr. Middeldorpff, of Breslau, has refined, and as it were perfected, the mechanical appliances of the process; to his monograph on the subject the reader is referred for a full account of the mechanism and surgery of the galvanic cautery.* The cautery in question possesses its chief superiority over the more usual form of actual cautery, in the easily regulated intensity and the duration of the temperature employed; in the facility with which its mechanical form can be suited to the external circumstances and other requirements of various parts of the body; in the intensity of the heat produced by the galvanic current, the rapidity with which this is communicated to the metal employed as a cautery, and the possibility of applying the heat subsequent to the introduction and proper adjustment of the instrument to the parts to be cauterised. It cannot but be regretted that the expense of the necessary appliances, and the cumbersome nature of the apparatus, tend to confine the use of this form of cautery to the exigencies of hospital practice. Besides the more obvious and general use of this remedy in the treatment of sinuses and fistulæ of almost every kind, and as a counter-irritant or styptic, Dr. Middeldorpff extols its efficacy in the treatment of stricture of the urethra; for removal of polypi, amputation of the penis and uvula, removal of the tonsils, and even suggests its application for the amputation of entire limbs; indeed he allots to the galvanic cautery a more extended sphere of action than any but its most ardent supporters could concede.

Platinum is the metal employed for localising the heat of the galvanic current, and for transmitting it to the parts to be cauterised. In all Dr. Middeldorpff's instruments an apparatus is fixed in the handle worked by a small screw, by means of which the galvanic current can be established or broken at will.

In treating fistulæ by this method, a platinum wire may be introduced into the track of the sinus, and being subsequently connected by its ends with the opposite poles of the battery, the cauterisation may be effected.

Dr. Middeldorpff has figured and described a very convenient and narrow-pointed platinum cautery, adapted to narrow sinuses or lacrymal fistulæ; in such cases he recommends the use of a small speculum to protect the surrounding parts. For the removal of tumours, polypi, and other outgrowing parts, a species of écraseur is provided; the chain in this instrument is replaced by a platinum wire, which can be tightened at will by an apparatus attached to the handle. Again, for cauterising strictures of the urethra, Dr. Middeldorpff has invented a species of catheter, containing a concealed platinum point, to be projected and heated by an arrangement connected with the handle of the instrument. As a counter-irritant there is no superiority attaching itself to the galvanic cautery above the ordinary forms of actual cautery; but such as prefer to employ it may find in the work referred to above a description and figure of a small porcelain cone surrounded by a spiral platinum wire, expressly intended for the formation of caustic issues.

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* *Die Galvanocaustik*, Breslau, 1854.

STRANGULATION OF NÆVI AND OTHER TUMOURS.

Nævi and some other small tumours may be strangulated by external or by subcutaneous ligatures. The most simple form of external ligature, and such as is well suited for small growths that are partly cutaneous and partly subcutaneous in their origin, consists in passing beneath the growth two fine hare-lip pins at right angles to each other. These should enter the skin clear of the nævous structure, and passing completely beneath its base, should emerge through the sound skin beyond; a piece of strong twine being wound around beneath the needle-ends, the growth may be strangulated and the whole secured by a double knot (fig. 7). For convenience, the needle-ends may be shortened, and a strip of lint may be wound beneath them to protect the surrounding skin, the whole being left to come away by sloughing. By some the needles are made use of only to raise the nævus during the tightening of the ligature; being withdrawn just before the knot is tied.

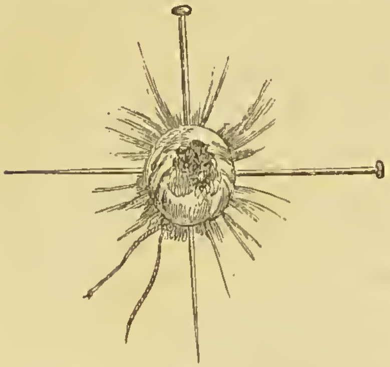
fig. 7.

Again, a good plan, and efficacious for small nævi, recommended by Mr. Cooper Forster, is to tie the nævus upon the pins, withdraw them, and four or five hours afterwards to cut or untie the ligature. The crushing which the nævus or its vessels of supply undergo in this process leads to the wasting and shrivelling up of the growth, which separates in two or three weeks in the form of a dry, scabby lump; the resulting cicatrix is less considerable than that left by the ordinary plan of external ligature.

To lessen the pain of the ligature, and to hasten the separation of the slough, it is advisable to trace with the point of a small knife a groove in the skin in which the ligature may lie; this incision should run around the base of the nævus, connecting one needle-puncture with another. Some nævi, though of considerable size, are covered with sound skin, or a disproportionately small extent of this is affected. In strangulating such, before passing the ligature around the pins, a crucial incision may be made over the surface of the growth down to its base at the points where the pins pierce the integument; the four included flaps being reflected, the ligature is applied within them, so that after the separation of the slough they may in part at least cover the denuded surface. It is probable, however, that nævi situated at such a depth beneath the surface, and with the integuments so little affected as to admit of this proceeding being adopted, would be more suitably treated by injection or complete excision.

Subcutaneous ligature. For the convenience of description, under this term all such ligatures will be described as are passed subcutaneously either around the nævus or beneath it, whether completely or only partially beneath the skin.

The partially subcutaneous ligature, which is ordinarily in use for mixed nævi of large size, may be so arranged as to strangulate the growth (*a*) in halves, (*b*) in quarters, or (*c*) in as many portions as its size or shape may require.

(*a*) For strangulating a nævus in halves, a strong stout needle, or one fixed in a handle with an eye at the point, being armed with a double thread, may be passed beneath the growth, so as to be quite clear of the nævous structure. The looped end of the twine being cut, the four ends may be grasped and used to raise the growth, while a pin is passed beneath it at right angles to the track of the ligature. The opposite ends of each portion of the ligature may now be tied together firmly beneath the end of the pin on the same side; the latter being shortened to a convenient length, the growth may be allowed to separate by sloughing (fig. 8), or the pin may merely be used to raise the nævus upon during the tightening of the knot, and be subsequently withdrawn. It is advisable to divide the skin around the nævus in the track of the ligature, just before drawing the latter tight.

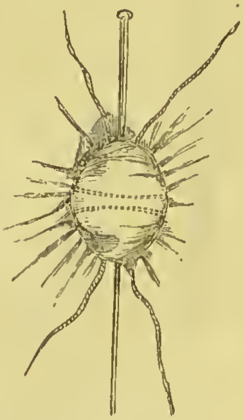

fig. 8.

For carrying ligatures beneath nævi, besides the common needle (fig. 9 *a*) and that which has an eye opening and closing at will, shown in fig. 9 *b* and fig. 10, there is a convenient needle, with a slit in the side of the eye, closing with a spring, from which the thread can be disengaged by simply pulling on the loop (fig. 9 *c*).

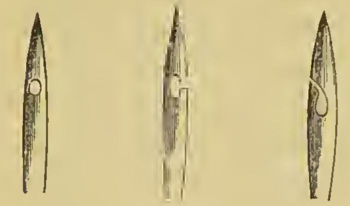

fig. 9.

(*b*) Of the plans in use for tying nævi in quarters, there are two of almost equal efficiency; the one introduced by Mr. Fergusson, the other recommended by Mr. Cooper Forster. The latter gentleman uses a needle with an eye near the point, which opens at will, so as to disengage the thread by pushing a button attached to the handle (fig. 10). The needle being thrust beneath the centre of the nævus, and out at the opposite side, the eye is opened, and the loop of a long and strong piece of twine is introduced, and retained by closing the slit in the side of the needle, which is withdrawn, bringing with it the double ligature, one end of which is divided, and the other, being carried a quarter of the way round the nævus, is thrust with the needle beneath the growth at right angles to its former course. This thread is now detached, and one end of the other thread is passed into the needle's eye and withdrawn with it beneath the nævus; the skin being divided to receive the ligature between the points of perforation, the four ends of the ligature may be tied together two and two.

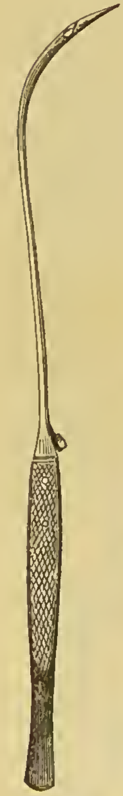

fig. 10.

Mr. Fergusson makes use of a strong curved suture-needle, having a large eye. This being threaded on the middle of a long and strong piece of twine, is passed beneath the nævus, the double thread being drawn half its length out on the opposite side; the loop is now divided on one side of the eye of the needle, and the opposite end of the thread that was cut is passed into the eye. These two ends are then carried with the needle beneath the nævus at right angles to the former course of the thread; the four free ends can then be tied two and two, the skin having been divided in the track of the ligature (fig. 11).

In addition to the proceedings above described, there is a method of strangulating a vascular tumour in four quarters, by passing beneath it at right angles two double threads in separate needles, and tying the eight ends together two and two in four knots. This plan is objectionable, as the thorough strangulation of the nævus depends upon the tying of the last two threads; when these are tightened, they frequently draw the knots of the other ends into the needle-holes in the integument, and thus prevent the complete strangulation of the growth.

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* The eye of the needle is here shown open.

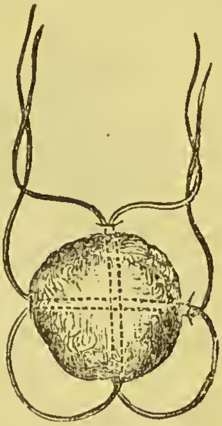

fig. 11.

(*c*) The shape and size of a nævus, or the external conformation of the part upon which it is situated, may be such that the above-described ligatures are unsuitable for effecting its strangulation; for such cases, especially where the growth is of oblong form, a thread may be passed beneath the growth at suitable intervals, and the included portions be separately tied up. For this purpose, a large curved suture-needle may be threaded on the middle of a long piece of twine, one half of which has been previously dipped in ink, or otherwise coloured. The needle may be passed beneath the growth at right angles to the long axis of this, at suitable intervals backwards and forwards, until the whole disease has been included between the threads. All the black loops of the twine on one side being cut, and all the white loops on the opposite side, each pair of white ends may be tied together on the one side, and on the opposite each pair of black ends (fig. 12). If it be thought necessary, hare-lip pins may be used in conjunction with this form of suture, being passed at right angles to the course of the thread; they may be used either to raise the growth during the tightening of the knots, or they may be left in situ until sloughing takes place, to insure that the ligature, in cutting its way through, shall pass completely beneath the disease.

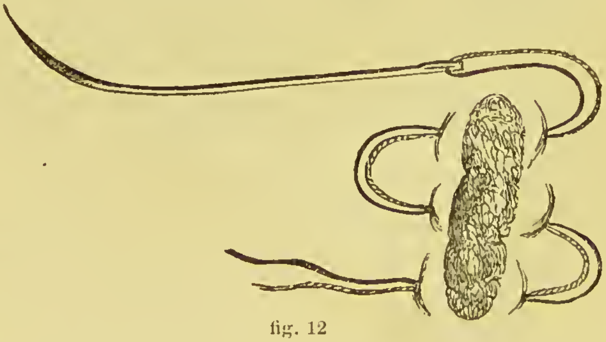

fig. 12

Completely subcutaneous ligatures, when applied for the strangulation of vascular tumours, may be so arranged as to include the growth in (*a*) a single loop, or (*b*) in two portions.

(*a*) To strangulate a nævus with a subcutaneous ligature in a single loop. A strong curved needle carrying a stout ligature is passed into the cellular tissue, close to the nævus, and carried around the circumference of the disease as far as the needle will conveniently reach (of course the concave side of the curve of the needle should be turned towards the nævus in effecting this); the needle-point may then be protruded, and the ligature and needle drawn out, to be again introduced at the same hole, and carried onwards in the same direction, until the whole nævus has been surrounded, the needle being at last brought out at the point where it first pierced the skin (fig. 13).

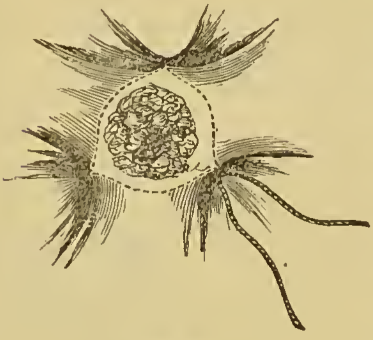
fig. 13.

(*b*) To produce strangulation of a large nævus, it may be necessary to tie up each half separately; to effect this with a subcutaneous ligature, a double thread being carried beneath the base of the growth, the loop on one side of the eye of the needle may be divided, and each end of the thread be carried separately back beneath the skin, round the opposite semi-circumferences of the growth; the needle being introduced at the former point of exit, and emerging where it first pierced the skin. The opposite ends of the same threads being tied together, the two halves of the nævus will be separately strangulated (fig. 14).

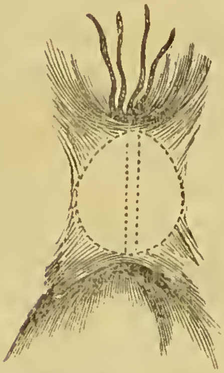
fig. 14.

THOMAS SMITH.

AMPUTATION.

AMPUTATION is often regarded as an opprobrium of the healing art. But while the human frame remains liable to derangement from accident and disease, the removal of hopelessly disordered parts, in the way most conducive to the safety and future comfort of the sufferer, will ever be a noble object of surgical effort. Indeed, the progress of medical science, while furnishing the means of curing some affections once regarded as hopeless, and thus in one sense restricting the field for the application of amputation, has in another point of view extended that field, by improving the mode of operative procedure, and divesting it of much of its terror and danger; so that whereas in former times the removal of a limb was only resorted to in cases of the most serious nature, it is now often practised when the offending member is merely a source of inconvenience.

It is instructive to trace the history of the improvement of this department of surgery.

Hippocrates (B.C. 430) recommended only a very rude kind of amputation, consisting of cutting through mortified limbs at some joint, "care being taken not to wound any living parts."*

On the other hand, Celsus, who seems to have lived at the commencement of the Christian era, advised that the removal of gangrenous limbs should be effected between the dead and living parts, and so as rather to take away some of the healthy textures than leave any that were diseased; and as he interdicted amputating through an articulation, his operations must often have been performed entirely through sound tissues. He directed that the soft parts should be divided with a knife down to the bone, and then dissected up from it for some distance, so as to allow the saw to be applied at a higher level. The rough surface of the sawn bone was then to be smoothed off, and the soft parts, which, as he tells us, will be lax if this plan be pursued, were to be brought down so as to cover the end of the bone as much as possible. This method seems calculated to afford good results; particularly as it appears probable from his writings that Celsus employed the ligature for arresting hæmorrhage after amputation,* and dressed the stump in a manner favourable to the occurrence of primary union.

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* *Hippocrates de Articulis*, p. 639 of the Sydenham Society's translation.

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* On this interesting point in surgical history I am disposed to agree with the author of the article "Amputation" in Rees's *Cyclopædia*, in opposition to the prevalent opinion that Celsus employed the ligature only in ordinary wounds, and used the actual cautery in amputations. The directions of Celsus regarding amputation are contained in his chapter on the treatment of gangrene, in which the only mention of hæmorrhage is the statement that patients often die of it during the performance of the operation (*in ipso opere*), referring doubtless to profuse bleeding resulting from ignorance of the circulation of the blood, and of any means of controlling it in the limb. Certainly this expression is no proof that the cautery was used rather than the ligature; for the former is in truth the more speedy method of the two. Neither is the absence of allusion to the ligature in this passage any evidence against its employment after amputation; for the argument would apply equally to the cautery, and no one doubts that one of these two means was used. Celsus, who is remarkable for his extremely concise style, leaves us to refer to his previous chapter on wounds, in which the subject of hæmorrhage is very ably discussed. In slight cases pressure with dry lint, and a sponge wrung out of cold water, is recommended, or if this does not answer, lint steeped in vinegar is to be used; but any portion of dressing retained in the wound is said to do mischief by causing inflammation; and on the same principle caustics and other powerful styptics, though very efficient in arresting the bleeding, are prohibited because they produce a crust, which acts like a foreign body. In more severe cases the vessels are to be tied; and finally, "when the circumstances do not even admit of this," the red-hot iron may be used as a last resort.

The only thing that seems to me to give any colour for doubt upon this subject, is the manner in which the ligature is described, "venæ quæ sanguinem fundunt apprehendendæ, circaque id quod ictum est duobus locis deligandæ intercidendæque sunt;" language which seems rather to apply to a partially divided artery than to one completely severed; but as the context shows that the ligature, as used by Celsus, was applicable in the majority of cases, and to more vessels than one in the same wound, it can hardly be conceived possible that the practice was restricted to the very rare case of partial division.

Again, there can be little doubt that in drawing down the soft parts over the bone after amputation, Celsus aimed at primary union, the great advantages of which are strongly insisted on in the same admirable chapter on wounds; but it is certain that he knew that the use of the cautery would have destroyed any chance of union by first intention.

One argument that has been urged on the other side is, that if he had employed the ligature in amputation, it would hardly have been neglected by his successors: but the slowness of the Surgeons of the sixteenth and

Archigenes, who practised in Rome shortly after the time of Celsus, paid special attention to the control of hæmorrhage during the performance of the operation; and appears to have been the first to employ for this purpose a tight band or fillet encircling the limb above the site of amputation. But while in this he did good service, he applied the red-hot iron to the surface of the stump, and also neglected the dissection of the soft parts from the bone, advised by Celsus, though compensating to a certain extent for this omission by retracting the integuments before dividing them.*

Galen, who was in truth more of a physician than a surgeon, declined still more from the Celsian precepts, and, reverting to the practice of Hippocrates, advised amputating through the dead tissues, and applying the cautery to the residue of the mortified part;† and for several centuries after his time either this method or others equally rude and often much more barbarous continued to be employed.

During the middle ages, the ligature, though used for ordinary wounds, was never thought of in amputation; and whatever may have been the practice of Celsus in this respect, there is no doubt that the great French Surgeon Ambroise Paré, when he so applied it, in the middle of the sixteenth century, had all the merit of originality. But though he urged its superiority over the cautery with able argument, supported by his extensive experience in both military and civil practice, yet his teaching failed for a long time to influence Surgeons generally, either in his own country or in other parts of Europe.

The principal reason for this appears to have been that the fillet, which was the means still in use for controlling the bleeding during the operation, did not answer its purpose effectually, even in the ablest hands; so that the dread of hæmorrhage led most Surgeons to prefer the cautery as a more expeditious method than the ligature. We even find Fabricius of Aquapendente repeating, in 1618, Galen's timid doctrine of the danger of amputating

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seventeenth centuries to adopt it, in spite of the strenuous advocacy of Paré, with all the advantages of a printed literature, show how little weight is to be attached to this objection. The utter neglect, during the middle ages, of the Celsian method of amputation, and of his simple mode of treating wounds, may also be mentioned as analogous cases.

* Sprengel's *History of Medicine*, French translation, vol. ii. p. 81, and vol. vii. p. 312.

† *Galeni ad Glauconem*, lib. ii. cap. xi.

through living parts at all;* and in 1633 the celebrated Fabricius Hildanus, though describing the ligature, states that the time which it occupies, and the consequent loss of blood, make it suitable only for the robust and plethoric, and declares that he "cannot sufficiently extol the excellence" of the *cauterium cultellare*, or red-hot knife, by which the orifices of the vessels were sealed while they were divided.†

In consequence of this same fear of bleeding, the great object at this period seems to have been to accomplish the work of severance of the limb as speedily as possible, and this was often done without any attempt whatever to provide a covering for the bone. Scultetus, in 1655, depicted the performance of amputation of the hand by chisel and mallet; and Purmannus, in his *Chirurgia Curiosa*, written as late as 1696, mentions having seen legs removed by two different Surgeons by modifications of a barbarous instrument of the middle ages, a sort of guillotine, "which, by its great weight and sharpness, cuts at once the skin, flesh, and bones asunder;" but states that it splintered the bone, and *therefore*, "all things considered, the ancient way of cutting through the flesh with a knife, and through the bone with a saw, is more practicable, safe, and certain."‡

As an example of the ordinary practice of the seventeenth century, may be mentioned that of Richard Wiseman, Sergeant-Surgeon to King Charles II. A fillet having been tightly applied, for the three-fold purpose of checking hæmorrhage, rendering the limb less sensitive by pressure on the nerves, and steadying the soft parts, which were retracted by an assistant, he carried a crooked knife by a single circular sweep down to the bone, which was divided with the saw at the same level, and the bleeding was arrested by the cautery, or some kind of styptic.§ Thus the mode of amputation employed by the father of British Surgery not two centuries ago, was precisely that used fifteen hundred years before by the Roman Archigenes. And very unsatisfactory were the results which it commonly afforded. The soft parts were insufficient, even in the first instance, to cover the end of the bone, which was accordingly cauterised, with the object of accelerating its inevitable exfoliation, and in the further progress of the case it tended to become more and more exposed by the contraction of the muscles; and even if the patient survived the protracted suppuration that ensued, he suffered more or less from the inconveniences of what has been called the sugar-loaf stump, being in the shape of a cone, the apex of which was formed by the prominent bone, covered either by a sore which refused to heal, or by a thin pellicle of cicatrix, very liable to abrasion.

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* *Hieronymi Fabricii ab Aquapendente Opera Chirurgica*, pars i. cap. xcvi.

† "Porro excellentiam hujus cauterii non satis extollere possum." *Gul. Fabricii Hildani Opera omnia*, lib. de Gangrænâ et Sphacelo.

‡ Purmann's *Chirurgia Curiosa*, English transl. book iii. chap. xii.

§ The ligature, though known to Wiseman, seems not to have been adopted by him. After describing different modes of applying it, in a way that shows pretty clearly that he had not practised them, he writes, "But the late discovery of the royal styptic hath rendered them of less use. But in the heat of fight it will be necessary to have your actual cautery always ready, for that will secure the bleeding arteries in a moment, and fortify the part against the future putrefaction." *Chirurgical Treatises*, book vi.

A great step towards a better order of things was made in 1674 by the French Surgeon Morel, in the invention of the tourniquet,* which, though at first but a rude contrivance, being a stick passed beneath the fillet and turned round so as to twist it up to the requisite degree of tightness, furnished the basis for the greatly improved instrument devised in the early part of the following century by his distinguished countryman J. L. Petit. This consisted essentially of two metallic plates, which could be separated from one another by means of a screw, so as to tighten a strap which was connected with them and also encircled the limb; and it is upon this principle that the ordinary screw tourniquet is still constructed. From this time forward, except in amputations performed near the trunk, hæmorrhage during the operation ceased to be an object of dread, and Surgeons were at liberty to consider other questions besides mere rapidity of execution.

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* English Surgeons might dispute with the French the honour of the invention of the tourniquet. In a work written in 1678, published in 1679, entitled *Currus Triumphalis e Terebintho*, Mr. James Young of Plymouth gives an account of a similar contrivance, apparently produced independently by himself. He describes it as "a wadd of hard linen cloth, or the like, inside the thigh, a little below the inguen; then, passing a towel round the member, knit the ends of it together, and with a battoon or bedstaff, or the like, twist it till it compress the wadd or boulster so very straight on the crural vessel that (the circulation being stopped in them) their bleeding, when divided by the incision, shall be scarce large enough to let him see where to apply his restrictives." p. 30. Further on in the book he states that the same principle is applicable with advantage in amputations of the upper limb. But as he does not inform us how long he had used this expedient before he wrote the account of it, the credit of priority must of course be accorded to Morel.

The improver of the tourniquet, and our own great countryman Cheselden, seem to have conceived independently of each other the idea of performing amputation by "double incision;" in which the skin and fat were first cut through by a circular sweep of the knife and retracted for about an inch, when the muscles and bone were divided as high as they were exposed.*

But this, though a great improvement, had only the effect of diminishing the cicatrix without covering the bone;† and Louis, another eminent Parisian Surgeon, believed that in the thigh the objects sought might be better attained by dividing all the soft parts at once, and sawing the bone at a higher level. In order to allow the muscles to contract freely when divided, he avoided the use of the tourniquet, and was the first to employ in its place digital compression of the femoral artery at the groin. He pointed out the important circumstance that the muscles on the posterior aspect of the thigh, being divided far from their origin at the pelvis, contract to a much greater extent than those at the anterior part of the limb, which are connected with the bone where they are cut; and he showed that, the soft parts having been severed to the bone by a circular incision and drawn up with a linen retractor, the saw might be readily applied two and a half inches higher up, after the knife had been carried through the attachments of the anterior muscles.‡ This method was amputation by double incision on a different principle; and though, in truth, a revival of the practice of Celsus, was not less valuable than the plan of Cheselden and Petit, and seems to have afforded results superior to theirs.§

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* It is difficult to determine to whom the priority belongs in this matter. Petit in his posthumous work states, "Je suis le premier qui ait coupé les chairs en deux temps;" and also, "J'ai imaginé de couper les chairs en deux temps;" and Dieffenbach, in his *Operative Surgery*, gives 1718 as the date of the introduction of the double incision by Petit. On the other hand, Cheselden as distinctly claims the original idea in the following passage in his notes to Gataker's translation of *Le Dran's Surgery:* "The thing that led me to do this was what has too often happened—the necessity of cutting off the end of the stump the second time. This operation I proposed to my master when I was his apprentice; but he treated it with neglect, though he lived afterwards to practise it when he had seen me perform it in the same hospital." This proposal must have been made before 1711, when, at the age of twenty-two, he began to lecture on anatomy.

† This is well illustrated by the drawing of a stump given by Cheselden in *Le Dran's Surgery*, for the purpose of showing the good effects of the double incision.

‡ *Mémoires de l'Académie de Chirurgie*, vol. ii. p. 286.

§ Ibid. vol. iv. p. 60.

Louis, however, was content if the stump when healed was free from conical projection,* and did not aim at forming a complete covering for the bone. This was effectually done about a quarter of a century later by Alanson of Liverpool, by dissecting up the integuments for some distance, and then dividing the muscles obliquely, so that they formed a hollow cone, in the apex of which the bone was sawn "about three or four fingers' breadth higher than was usually done." The effect of this was to "fully cover the whole surface of the wound with the most perfect ease;"† but in the hands of other Surgeons the oblique division of the muscles proved to be a matter of considerable difficulty, and the object was accomplished as efficiently and more simply by Mr. Benjamin Bell of Edinburgh,‡ and Mr. Hey of Leeds, by a combination of the methods of Cheselden and Louis; or, as Mr. Hey expressed it, "with a triple incision,"§ in which the skin and fat were first divided circularly and dissected up for some distance, then the muscles were cut at a higher level, and these were retracted so as to permit the bone to be exposed and sawn considerably higher. Mr. Hey added the advice to cut the posterior muscles somewhat longer than the anterior, to compensate for their greater contraction; and thus, towards the end of the last century, "the circular operation," as it is termed, may be said to have been brought to perfection.

Meanwhile a different principle had been long before suggested and acted on. So early as 1678, Mr. James Young of Plymouth described "a way of amputating large members, so as to be able to cure them *per symphysin* in three weeks, and without fouling and scaling the bone." The directions given for this method, the "first hints" of which he says he had "from a very ingenious brother of ours, Mr. C. Lowdham of Exeter," are as follow: "You are with the catling, or some long incision-knife, to raise (suppose it the leg) a flap of the membranous flesh covering the muscles of the calf, beginning below the place where you intend to make excision, and raising it thitherward of length enough to cover the stump; having so done, turn it back under the hand of him that gripes; and as soon as you have severed the member, bring this flap of cutaneous flesh over the stump, and fasten it to the edges thereof by four or five strong stitches."* Eighteen years later, Verduin, a Surgeon of Amsterdam, ignorant apparently of what Lowdham had done, provided like him a covering for the end of the stump from the calf; but instead of cutting from below upwards, and only raising the integuments, he thrust a knife behind the bones at the part where he intended to divide them, and cutting downwards formed a muscular flap, which he afterwards supported by an apparatus devised for the purpose of pressing the cut surfaces together so as to check bleeding without the use of either cautery or ligature.† This machine being complicated and unsatisfactory, was rejected in 1750 by M. Garangeot,‡ who, substituting the ligature for it, but retaining in other respects the method of Verduin, brought amputation of the leg to the form in which it is still often practised at the present day.

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* "L'amputation la plus parfaite est, sans contredit, celle dans laquelle les chairs qui forment l'extrémité du moignon conservent assez de longueur pour se maintenir au niveau du bout de l'os." Op. cit. vol. iv. p. 41.

† Alanson's *Practical Observations on Amputation*, 2d ed., p. 16.

‡ Benjamin Bell's *System of Surgery*, 7th ed., vol. vii. p. 260.

§ Hey's *Practical Observations*, 3d ed., p. 527.

The same principle was applied to the thigh, in 1739, by Ravaton, of Landau; but instead of one long flap he made two short ones. Having divided all the soft parts circularly, he thrust a knife down to the bone on the anterior aspect of the limb, a hand's-breadth higher up, and cut down to the circular wound; and, having made a similar longitudinal incision behind, dissected up the square lateral flaps thus formed, and sawed the bone where it was exposed at their angle of union, and brought them together after tying the vessels.§

Vermale, Surgeon to the Elector Palatine, soon afterwards formed the flaps more easily, and of a shape better adapted for union, by introducing a knife at the front of the limb and pushing it round the bone at one side, so as to make it emerge at the opposite point behind, and then cutting a flap of rounded form by carrying the knife in a curved manner downwards and outwards, the same process being repeated on the other side.‖

The flap operation, performed either by cutting from without inwards or by transfixion, was occasionally employed by various Surgeons in the latter half of the last century; but found its most strenuous advocate in the late Mr. Liston, and about twenty years ago seemed likely to supersede the circular method altogether. Its great merit is its facility and speed; for the flaps are cut with great rapidity, and when they are drawn up by the assistant, the bone is exposed with the utmost readiness at the part where it is desirable to divide it; whereas the dissection of the ring of integuments from the fascia is a somewhat troublesome and tedious process, especially in a limb increasing in thickness upwards like the thigh, and the use of a retractor is often necessary, in order that the saw may be applied at a sufficiently high level.

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* James Young's *Currus Triumphalis e Terebintho*, p. 108. A copy of this interesting book exists in the library of the Medico-Chirurgical Society of London.

† *Mémoires de l'Académie de Chirurgie*, vol. ii. p. 244.

‡ Ibid. p. 261.

§ Ravaton's *Traité d'Armes à feu*, p. 405; also *Mémoires de l'Académie*, vol. ii. p. 251.

‖ *Le Dran's Surgery*, Gataker's translation, p. 431.

As regards the immediate results of the two methods, the principal difference between them is, that the flaps, when formed by transfixion, contain a large amount of muscle, while the circular mode furnishes a covering chiefly from the integument. In this respect the flap operation was at first supposed to have a great advantage, as providing a muscular cushion for the end of the stump. But this opinion was shaken by further experience. In the very case in which the flap operation was first employed, viz. in the upper part of the leg, the muscular mass proved very inconvenient from its redundancy when the calf was largely developed; and even under more favourable circumstances the heavy and contractile flap was apt to shift from its position or to drag down the skin of the front of the leg, so as to stretch it on the cut end of the tibia, and induce ulceration. Hence Mr. Liston himself, so early as 1839, preferred in muscular subjects a short posterior flap and an anterior one of the same length, composed of integument only;* and in the latter period of his practice he changed this for the following modification of the circular operation, which was also suggested independently by Mr. Syme and has been used by him for several years past in all cases of amputation in this situation. The skin and fat are divided by two crescentic incisions with the convexity downwards, so as to form short antero-posterior flaps of the integument, which is raised from the fascia considerably higher than their angle of union, after which the operation is completed as in the ordinary circular method.† This plan gives essentially the same result as the circular mode, while the dissection of the integument is facilitated, and its edges can be accurately adapted to each other without any of the puckering that occurred at the angles of the wound after the old operation; and experience shows that when the soft parts have been divided in this way they are quite as favourably disposed for primary union as when cut more smoothly in the form of flaps.

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* Liston's *Elements of Surgery*, 2d edition, p. 786.

† Syme's *Principles of Surgery*, 4th edition, p. 148.

In the lower part of the thigh, also, the presence of the contractile element in the flaps was found to be injurious by increasing the disposition to protrusion of the bone, from the action of the powerful ham-string muscles, cut so far from their origin at the pelvis. Mr. Syme has accordingly adapted his modification of the circular method to that situation;* and I can testify, from considerable experience, to the sufficiency of the covering which it affords.

The longer time required for this operation than that by flap was rendered a matter of no moment by the discovery of anæsthesia in surgery, in the year 1846.† Independently of the relief from bodily and mental suffering procured by this great event, it must be regarded as an era in the history of amputation, of at least equal importance with the invention of the tourniquet; because Surgeons are now, in the great majority of cases, deprived of all excuse for sacrificing any thing, either in plan or execution, to mere rapidity of performance, and enabled to regard simply what will most promote the two great ultimate objects in amputation,—safety to life, and usefulness of the stump.

With regard to the latter object, in connection with the modified circular operation, it was found that patients on whom it had been performed walked as well as those who had the cushion which is produced by a muscular flap; but on investigation it appeared that in neither case was the weight of the body borne by the end of the stump, which, in fact, did not touch the artificial limb at all; the socket of the apparatus being applied partly to the sides of the stump, but chiefly to some bony prominence resting on its upper edge,—the tuberosity of the ischium when the thigh is concerned, and in the leg the internal tuberosity of the tibia, the head of the fibula, and especially the lower edge of the patella.

This subject has, however, been recently opened up afresh by Mr. Teale, of Leeds, who has brought before the profession a new mode of amputating, with facts which show that it enables patients to rest the whole or a large part of the weight of the body on the end of the stump either of a leg or thigh; and he states that when the pressure is pretty equally divided between that part and those which bear it in ordinary cases, the steadiness and comfort of locomotion are greatly increased. The manner in which this unquestionable advantage is attained by Mr. Teale is as follows. Having ascertained by measurement the semi-circumference of the limb where the bone is to be divided, he first traces with pen and ink upon the skin four lines of that length; two longitudinal, extending downwards from the part measured along the sides of the limb, and two transverse, of which one joins in front the lower ends of the longitudinal lines, while the other runs across behind from one longitudinal line to the other at the distance of a quarter of their length from their upper extremities. Two rectangular flaps of very unequal lengths being thus mapped out, he raises them by cutting from without inwards, and saws the bone at their angle of union ; then, after tying the vessels, bends the long anterior flap upon itself, that it may "form a kind of pouch for the end of the bone," turning up its lower edge to meet that of the short posterior flap, to which it is carefully adjusted and united by a few points of suture, some stitches being also introduced where the edges of the skin meet at the sides of the stump.*

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* Syme's *Principles*, 4th ed. p. 140.

† See the Section on Anæsthetics, which follows next in this work.

Mr. Teale also proposes to extend his method to the arm and forearm, and even to the fingers; but as the ordinary operations answer their purpose completely for these situations, it is not likely that Surgeons generally will substitute for them this complicated process.

Nor must it be supposed that stumps in the lower limb have never before borne the weight of the body. Mr. Alanson, speaking of the condition of a patient on whom he had performed amputation above the ankle by posterior flap, says: "He has been several voyages to sea, and done his business with great activity. He bears the pressure of the machine totally upon the end of the stump, and has not been troubled with the least excoriation or soreness."† It must be admitted, however, from Mr. Teale's statistics, that such a result is much more likely to follow his method than any other usually employed; and hence, in the leg and thigh, the trouble which it involves would be little thought of, were it not accompanied by other drawbacks. But when measurements are made in accordance with this mode upon a muscular subject, the anterior flap is found to present an extravagant length, such as, in many cases in actual practice, the available material would not suffice for, while in others a much higher division of the bone than usual would be required. Thus in a particular instance, where the development was by no means extraordinary, the dimensions were such, that, supposing the anterior transverse incision made at the level of the upper border of the patella, it would have been necessary, in order to preserve Mr. Teale's proportions, to saw the bone eleven inches further up, or full five inches higher than if the modified circular operation were performed.[*] This must, *ceteris paribus*, very seriously increase the risk, which is always greater the nearer the seat of amputation is to the trunk.[†] The cut surface is also very extensive, and this would give rise to a correspondingly large amount of suppuration if immediate union failed. It therefore becomes an important question whether the advantages of Mr. Teale's plan may not be obtained in some less objectionable manner.

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* Teale *on Amputation*, pp. 34 et seq.

† Alanson *on Amputation*, p. 133.

Now, in the first place, it is clear that the extent of cut surface might be diminished without at all interfering with the result, by retracting the muscles before dividing the bone, instead of trusting entirely to the flaps for covering it. Thus, in a limb sixteen inches in circumference, the effect of an anterior flap eight inches long, and a posterior flap of two inches, with the bone sawn at their angle of union, would be equally attained by an anterior flap of six inches without any posterior flap at all, but with the muscles retracted to the extent of two inches before division of the bone, just as is done in the circular operation. Secondly, as this single flap would be only slightly longer than the diameter of the limb, it would be needless to attempt to fold it on itself; but it would adapt itself well to the posterior part of the thigh if its angles were rounded off; while, at the same time, the operation would be divested of its difficulty; as a flap of such form could be readily shaped by the eye, and its length determined by spanning the limb.

That such a procedure would answer well is not, however, a mere matter of inference; for, since the appearance of Mr. Teale's work, Mr. Spence, of Edinburgh, has performed some amputations of the thigh according to his directions, and others by cutting from without inwards a large rounded anterior flap, dividing the posterior parts at the level of its base by a perpendicular sweep of the knife, and retracting the muscles before applying the saw.* I have had the opportunity of ascertaining by personal inspection the fulness of the cushion in both cases; and Mr. Spence tells me that, where it has been formed after the latter mode, it has proved capable of bearing a large proportion of the weight of the body.

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[*] At 9 inches above the patella the circumference of the limb was $20\frac{3}{4}$ inches; so if the operation were performed there, the length of the anterior flap (the semi-circumference) should be $10\frac{3}{8}$, which would encroach by $1\frac{3}{8}$ inch upon the unsound integument. At 11 inches above the patella the circumference was $22\frac{1}{4}$, giving an anterior flap of $11\frac{1}{8}$, which could barely be formed out of the given material.

[†] This principle has been pithily expressed by Dieffenbach in the words "zollweise steigt die Gefahr." *Operative Chirurgie*, vol. ii. p. 822.

Still this proceeding would involve as high a division of the bone as Mr. Teale's, if the anterior flap had the length above mentioned; and the question yet remains, whether it may not be curtailed, and eked out with a short posterior flap, without impairing the usefulness of the stump. Provided the covering of the bone be sufficiently full, the essential thing to be attained is, that the tender cicatrix shall be so placed as to be free from any chance of being squeezed between the bone and the bottom of the socket of the artificial limb. Now it fortunately happens, both in the calf of the leg and in the thigh, that the bone lies far forward among the muscles, so that even its posterior surface is considerably anterior in position to the longitudinal axis of the limb. Hence a flap of half the diameter of the limb would more than cover the bone, and one as long as two-thirds of that diameter would insure the scar being considerably behind the point of pressure; especially as the absence of the two inches of bone above the base of the flap would allow it to drop lower than it otherwise would. Also, in the further progress of the case, the contraction of the posterior muscles will draw the cicatrix still further back; an effect long since noticed by Alanson, who states, that after his circular operation, "as the cicatrix is so small, viz. only a single line drawn across the face of the stump from side to side, the parts are sooner capable of bearing the requisite pressure from the use of a wooden leg; for this does not fall upon the new-formed skin, which is drawn backwards by the action of the posterior muscles."†

In order to compensate for the diminution of the anterior flap, a posterior one must be made of rather more than half its length, and of rounded shape for adaptation to it, and the integument of this flap should be dissected up before the posterior muscles are divided, so as to set it free from the effects of their contraction. On the other hand, the anterior flap, after being marked out by carrying the knife through the skin and fat, should be raised so as to contain a good deal of muscle, which will be useful, both by insuring the vitality of the rather long flap, and also by increasing the thickness of the cushion below the bone; while any tendency to retraction that it possesses (small compared with that of the posterior muscles) will be counteracted by the force of gravity, through which it will naturally tend to occupy its proper place.

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* *Edinburgh Monthly Journal*, November 1859.

† Alanson *on Amputation*, p. 85.

By this mode of amputating, the bone will be divided about as low as in the modified circular operation; and though I have not yet had much opportunity of trying it upon the living subject, I feel satisfied, from the above considerations, and from experiments upon the dead body, that it will attain the essential objects of Mr. Teale's plan, while it will occupy less time than either of the methods alluded to. The flaps, when brought together, will be free from tension, and the stump, if properly dressed, most favourably circumstanced for safe and speedy healing.

The dressing of the stump is a matter quite as important to the successful issue of amputation as the manner in which the limb is removed; and therefore requires special notice here.

The essential principles upon which it ought to be conducted will be best understood from a consideration of the circumstances of the wound after the operation. The mechanical irritation resulting from the passage of the instruments through the parts appears to throw a thin layer of the tissues at the cut surface into a state similar to that produced by the action of cantharides upon the skin, or tincture of iodine upon the tunica vaginalis; viz. a condition of suspended vital activity, in which, the normal relations between the blood and the living solids being interrupted, the minute vessels become clogged with the blood-corpuscles, and the liquor sanguinis is forced through their parietes, and flows out upon the surface of the wound.* The liquor sanguinis, lying upon the sluggish tissues, comports itself as if in contact with ordinary solid matter, its fibrine coagulating to form the lymph which encrusts the cut surface, while its other and far larger constituent, the serum, trickling away between the lips of the wound, shows itself as the discharge which soaks the dressing during the first twenty-four hours. Meanwhile, the source of irritation being no longer in operation, the tissues, if free from any disturbing cause, are gradually recovering their powers by virtue of their inherent vital energy; and, as they regain their functions, the effusion of plasma ceases, and a process of active organisation is instituted, by which the lymph is differently affected according to circumstances. If the surfaces of the wound are in juxtaposition, the lymph glues them together, and, being surrounded on all sides by healthy tissue, becomes developed in a few days into a soft vascular structure, which constitutes a permanent bond of union between them. But if the surfaces of the wound are separated by a portion of the dressing, or a clot of blood, or by serum pent up in the interior, immediate union is of course prevented; and, in the vicinity of the foreign solid, or the decomposing blood or serum, the development of the lymph assumes a very low type, and pus is the result. But, independently of any mechanical obstacle to union, if some persistent source of local irritation be present, such as the dragging of stitches upon an insufficient covering of soft parts, or a tightly constricting bandage, inflammation will be induced in a reflex manner through the medium of the nervous system, and, in proportion to its degree, will interfere with the process of organic development; converting what promised primary union into suppuration; or, if more severe, rendering the lips of the wound entirely inactive, incapable of producing even pus; or, if still more intense, depriving them of their vitality and causing sloughing of the stump.

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* See a paper, by the Author of this Section, "On the Early Stages of Inflammation," *Phil. Trans.* 1858.

Thus, while the effusion of the lymph which is the medium of primary union, depends on a species of traumatic inflammation of the cut surface, the healthy organisation of that lymph requires absence of any inflammation whatever; and the great object of treatment must be to place the stump in such circumstances that the tissues may be left undisturbed, to recover from the shock they have sustained and then exert their powers upon the product of their derangement.

Supposing, then, that the operation has been properly performed, so that the soft parts may meet over the bone without any tension, and that the orifices of the bleeding vessels have been carefully secured, the following simple rule will be found of universal application. Let the dressings be destitute of any irritating quality, and so arranged that the surfaces of the wound may be kept in gentle apposition throughout, while free opportunity is afforded for the escape of discharge.

The last point is of essential moment; for a flow of serum, copious in proportion to the extent of the cut surface, is, as we have seen, an inevitable effect of the operation: and though, when it has ready egress, it is probably beneficial, by washing out blood that may ooze into the wound before it has time to coagulate in the interior,* yet if retained, it will prove mischievous, not only by rendering union mechanically impossible in the parts where it accumulates, but by irritating the stump through the distension which it produces, and the acrid properties which it acquires from decomposition.

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* The mixture of blood and serum which stains the dressings is very often mistaken by patients for bleeding.

In the later stages of the case it is equally necessary to provide for the free escape of discharge. For in a wound of such extent and irregularity as that resulting from amputation, we can never be secure against the formation of some pus in the interior, which, if retained, would give rise to all the evils of abscess. To guard against such an occurrence, the stump must be from time to time carefully examined. But if the operation be performed through healthy tissues, no suppuration will take place till about four days have elapsed;* so that any meddling with the stump before that time is unnecessary: and such premature interference does great mischief by tearing the yet imperfect and delicate uniting tissue.

The records of Surgery show that a rapid cure after amputation has depended more upon the stump having been dressed in accordance with these principles, than upon the shape in which the covering of soft parts has been cut. In the original account of Lowdham's method, before quoted, Mr. Young states that the wound healed *per symphysin* in *three weeks;* and in describing the dressing, he says, "clap a dossil of lint into the inferior part, that one passage may be open for any blood or matter that may lodge between, but of that there seldom occurreth any." The essential exit for the serum was thus provided; and it is to be remembered that Lowdham's flap was not a heavy and contractile mass of the muscles of the calf, but consisted only of the skin and fat, and therefore would lie in its place without tension.†

The stumps formed after Ravaton's fashion, with two lateral rectangular flaps, healed very quickly, both in his hands and those of Le Dran, who states that the cure was completed in three weeks; and accordingly we find that neither of these Surgeons employed any irritating application, and that both were careful to leave the inferior longitudinal incision freely open for the escape of the ligatures and the discharges.‡ Ravaton insists especially upon this as a grand source of safety to the patient, and states that "the drain which exists below prevents any mishaps, such as swelling, inflammation, abscess, &c.; no exfoliation of the bone occurs, and the suppuration is infinitely less abundant than in the old method, both because the wound of the stump has but a small surface or none at all, and because the inferior incision allows the pus to flow freely away, and in a short time this great wound is seen to be soundly healed."

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* This is the period in adults and in cool weather; in young subjects and in warm weather it is somewhat short of four days.

† *Currus Triumphalis*, p. 111.

‡ Ravaton, *Traité des Playes d'armes à feu*, p. 408; and Le Dran, Gataker's translation, p. 431.

It seems strange, that after such results had been attained and clearly recorded in France, the Surgeons of that country should afterwards have preferred stuffing with charpie the wound produced in amputation; and that O'Halloran of Limerick, who wrote in 1765, and gained considerable reputation as a supporter of the flap method of amputation, while priding himself on his familiarity with the works of the French Surgeons of his time, should have discredited altogether their reports of primary union, and considered that he did great service to Surgery in asserting the principle that "healing by inosculation without suppuration, by an immediate coalescence or by the first intention, is merely chimerical, and is opposite to the rules of nature."*

But his influence was happily effectually counteracted, as far as British practice was concerned, by the teaching of Alanson, who was a warm advocate for primary union, both after flap and circular operations. Such success attended his practice, that out of thirty-five cases of amputation of the leg and thigh at the public hospital of Liverpool, he lost not a single patient; and he tells us that "at the expiration of a month from the operation, the wound" was "either perfectly healed or less than a sixpenny piece."† These results cannot be attributed entirely to good fortune; neither can they be explained by the peculiar conical form of the wound made by his oblique division of the muscles (which indeed did not occur in the leg amputations); but they are sufficiently accounted for by his after-treatment.

In the first place, he paid special attention to securing the vessels, examining "the whole surface" of the wound "with the greatest accuracy," and drawing out the vessels with the tenaculum and tying them "as naked as possible;" and, says he, "no one will assert that in a single instance I have removed the dressings before the usual time, on account of hæmorrhage." Secondly, in amputations of the thigh he employed a flannel roller, fixed round the pelvis and carried circularly down the limb, "not so tight as to press rudely or forcibly, but to give an easy support to the parts;" and there is no doubt that such a bandage acts beneficially, not only by checking retraction of the soft parts, but by keeping the muscles in a state of repose, and thus preventing the disturbance of the process of union, which would result from their irregular contractions. Thirdly, the edges of the skin, after his mode of operating, generally met without the slightest tension, and were retained in apposition merely "by long slips of linen or lint, about two fingers in breadth, spread with cerate or any cooling ointment," between which the serum would freely escape and soak into the rest of the dressing, which was simply "a soft tow-pledget and compress of linen, the whole retained with the many-tailed bandage," while the exit of discharge was favoured by the low position in which he placed the stump, viz. about a hand's-breadth from the surface of the bed. The dressings were first changed on the third or fourth day, and he advises that this should be done "with as much tenderness as possible;" but the flannel roller was not interfered with till some time later, when the "adhesions" were "more complete."

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* O'Halloran *on Gangrene*, &c. p. 220.

† Alanson, preface, p. 16.

In short, the mode of dressing pursued by this excellent Surgeon was in all respects truly admirable; and well would it have been for the credit of British Surgery had his successors been equally clearsighted and judicious. But though all followed him in attempting primary union, their very anxiety to obtain it, not being supported by sound pathological knowledge, often led to entire failure. Thus Mr. Syme informs us,* that when he was a dresser in the Edinburgh Infirmary, it was usual in recent wounds to bring the edges of the skin into close contact by strips of adhesive plaster overlapping at their edges, so as to allow no escape for blood or serum; and when these were removed, on the fourth day, a collection of fetid pus was almost invariably found separating the surfaces of the wound. So impressed was he with the evils of this practice, that he published in 1825 a paper on the subject,† in which he insisted on the invariable occurrence of a flow of serum, the retention of which was necessarily injurious; so that, as he expressed it, "there can be little difficulty in perceiving why the sealing-up of wounds should be the most certain means of keeping them open;" and he pointed out "that pressure should be directed to the bottom rather than to the outlet of the wound." This paper had a very important influence, the principles inculcated in it being afterwards infused into London practice by the late Mr. Liston, besides being steadily taught and acted on by their author in the Edinburgh school. Mr. Liston continued to the last a practice which Mr. Syme at first suggested, viz. leaving the wound open for some hours before the final dressing, in order to obtain greater security against secondary hæmorrhage. But Mr. Syme afterwards found that, except in case of extensive oozing from minute vessels, the disturbance of the wound involved in this plan was an unnecessary infliction on the patient, and if sufficient pains were bestowed upon securing the arteries, the dressing might at once be completed. This consisted of points of the interrupted suture at sufficient distance from each other to afford a free outlet for discharges, and pads of folded lint applied over the bodies of the flaps but not extending to the lips of the wound, with a broad piece of lint over all, and a bandage applied so as to press the deep surfaces of the wound gently together through the medium of the pads; while the cutaneous margins were left free for the exit of the discharge, which was absorbed by the lint as it escaped. This, though at first a dry dressing, became practically a moist one, and prevented the blood or serum from drying so as to form a crust. It was left undisturbed for about four days, when union was found already pretty firm; and a similar application being afterwards repeated at intervals of two days, the discharge of pus was commonly very trifling in amount, and the cure speedily accomplished. This was the method followed during my house-surgeoncy under Mr. Syme; at the expiration of which he was able to state,* that "of the last twenty cases in which he had amputated the thigh in that hospital for chronic disease, not one had died, although some of them were almost hopeless at the time of the operation, on account of the extreme degree to which they were prostrated by long-continued discharge or other causes." And there can be no doubt that one reason for this success was, that the stumps were treated on sound principles.

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* Clinical Lecture in the *Lancet*, March 31st, 1855.

† *Edinburgh Medical and Surgical Journal*, vol. xxiv.

Stitches are certainly preferable to strips of adhesive plaster for keeping the edges of the skin in contact, as they occupy much less room, and so oppose less obstacle to the escape of discharge; and the only objection ever urged against them, viz. that they induce inflammation round the points where they are inserted, has been entirely removed by the introduction of the metallic suture, which causes no irritation whatever unless it subjects the part to traction, and this ought never to be the case after amputation. When applied without tension, the wire-stitches may remain for any length of time without producing more disturbance than a ring of gold in a lady's ear;* they consequently retain their hold for a much longer period than silk or linen, so that strapping may usually be entirely dispensed with, which greatly simplifies the dressing.

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* Clinical Lecture, *Lancet*, April 21st, 1855.

A padding of some soft material suited for imbibing the discharge, and arranged according to the principles indicated above, appears to be useful, by giving general support to the stump, and keeping the deep surfaces of the wound together, and so checking oozing of blood and promoting union; and by careful management such a dressing may be renewed on the third or fourth day without disturbance of the plastic process.

Should redness and tension of the integument indicate inflammation of the stump, any tight stitches must be removed, and the dry application must give place to a warm and moist one, to be renewed daily. Where union is incomplete, any unhealthy state of the granulations must be treated like the same affections of ordinary ulcers; and if erysipelas or hospital gangrene should arise, they also must be dealt with on general principles. Exfoliation from the bone, once an invariable attendant on amputation, is now rarely met with, except as the result of mismanagement. When it does occur, the dead portion must of course be removed as soon as examination with the probe shows it to be loose.

Before considering the operations best adapted for particular cases of amputation, it will be well to allude in a general way to the necessary instruments, and the mode of using them.

The amputating knife should have a straight and strong back, and a sharp point, near which the edge should present a gentle convexity. In the old circular amputation, a curved knife with a blunt extremity was employed to divide the integument at one continuous sweep; but as the modified operation is always preferable, in which the skin is cut in the form of short semilunar flaps, this somewhat clumsy implement may now be entirely dispensed with. For a flap operation performed by transfixion, the blade should be about half as long again as the diameter of the limb; but when the soft parts are cut from without inwards, a much shorter knife will answer the purpose, and should therefore be preferred, as the movements of the smaller instrument can be directed with greater precision and speed. For removing a finger or toe, something intermediate between the tapering bistoury often used in France and the old round-bellied English scalpel will be found to combine the advantages of both without the inconveniences of either, being equally adapted for piercing and cutting.

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* I am happy to be able to confirm fully the original statement made on this subject by Dr. Sims of New York, to whom the profession is indebted for demonstrating the value of the metallic stitch. For passing the wire smoothly through the tissues, a needle suggested by myself some years ago, and since constantly employed in the Edinburgh Infirmary and many other places, will, I believe, be found the most convenient. It is grooved at each side from the eye to the blunt end, these points being further from one another than in an ordinary needle. Care must be taken to hold the wire in the grooves while twisting its ends together, after which it will be found securely incorporated with the needle.

In using the knife, the young practitioner will have to unlearn some of the habits he has acquired in anatomical study. The object being now simply to divide the resisting textures efficiently, the stroking and scratching movements of the dissecting-room must be changed for a free sawing motion; and for this purpose the knife must be held firmly in the hand, instead of being kept in the feeble position best suited for the investigation of delicate structures.

There is another error to which the habits of dissection may lead, far more serious than a cramped and awkward use of the knife, viz. that of directing the edge of the instrument towards the skin in raising a flap of integument. Such a practice, necessary in anatomy, to avoid injury to the subcutaneous structures, will, if carried into amputation, most seriously endanger the vitality of the flap, which derives its supply of nourishment from vessels ramifying in the fat, and must perish if those vessels are extensively divided through scoring of the *tela adiposa.* I am satisfied that integument designed to form a covering for the stump is often made to slough, for want of scrupulous attention to this simple principle.

The skin should always be cut perpendicularly to its surface, for if it is beveled off to a thin edge, it is not only unsuited in shape for adaptation with a view to primary union, but the margin may slough for lack of nutriment.

In transfixing a limb, the direction of the knife must of course be changed as it passes round the bone, in order that it may emerge at the opposite aspect; but it is desirable that this should be done in a continuous manner; for if the instrument be thrust in for a certain distance, and then partially withdrawn and made to follow a new track, the punctured wound first made may cause very troublesome hæmorrhage, if a considerable arterial branch happen to be divided in it.

In passing the knife round a bony prominence, such as the shoulder, care must be taken to hold the limb in such a position as shall relax the parts that are to be pierced, otherwise what might be quite easy may prove impossible; and in the latter part of the process, when the point of the knife is advancing in a greatly altered direction, it is important to keep the back rather than the edge directed to the surface, in order to avoid cutting the base of the flap.

In amputating at a joint, if the tissues are healthy, the division of the soft parts completes the process, there being no need to take away the articular cartilage, which is almost as favourably circumstanced for healing as vascular structures. Thus, when a finger is removed at the metacarpo-phalangeal point, the whole wound may unite by first intention; and after amputation at the shoulder, where complete immediate union cannot be expected, the cartilage undergoes a change into granulations by a process so speedy as hardly to delay the cure.

The saw, for dividing the bone in other cases, should be broad-bladed, with a stout back, like the "fine saw" of the carpenter, and should have small but well-set teeth. In order to promote the smoothness of its action, it may be smeared with a little olive-oil. In applying the instrument, its heel being placed upon the bone, previously cleared of soft parts by a circular sweep of the knife, it should in the first instance be drawn with firm pressure towards the operator, so as to make a groove which it will have no disposition to quit in the first forward stroke. The bone is thus cut precisely at the place desired, while any scratching of the neighbouring parts of the osseous surface is avoided, which, besides involving loss of time, would be apt to give rise to a small exfoliation.

The assistant who holds the limb must take care not to press it forcibly upwards, otherwise the saw will become locked; nor must he draw it downwards to any great degree, or the bone will break and splinter towards the last. Should any projecting portion be left, it must be removed with a pair of bone-pliers, which may be substituted entirely for the saw when the bone is of very small size, as in the fingers. In using them, the flat surface should always be directed towards the parts that are to be preserved, as the other sides of the wedge-shaped blades crush the bone while they divide it.

The tenaculum, long universally employed for seizing the bleeding vessels in order to tie them, has been superseded by the catch-forceps, which, like the bone-pliers, were introduced into surgical practice by the late Mr. Liston. Besides being always more convenient, they have the great advantage of making the Surgeon independent of an assistant in cases of emergency. The ligature, consisting of stay-silk or strong thread well waxed, should be tightly and securely tied, by reversing in the second half of the knot the relation that the ends of the thread had to one another in the former half, or, in the language of sailors, by making a "reef knot." The larger vessels should be drawn a little way out of their sheaths, as the best means of avoiding nervous trunks and other unnecessary tissue. Of the smaller branches, as a general rule, all that are seen to pulsate should be tied, mere oozing being checked by the gentle pressure of the dressing; but in order to render conspicuous all that require tying, it is safest, before dressing the stump, to put the surfaces of the wound in apposition for a short time, and bathe the integument with warm water, so as to induce relaxation of contracted arteries which might otherwise cause secondary hæmorrhage. Many Surgeons make a point of cutting off one end of each ligature; but this is waste of time and trouble, unless the threads are unusually numerous.

When the tourniquet is employed, it should be kept loose till the operation is about to commence, when it should be screwed up as rapidly as possible, to avoid an intermediate degree of constriction, which would check venous return without preventing arterial flow, and produce engorgement of the limb with blood which would be lost to the patient. When it is of great importance to retain as much of the vital fluid as possible, it will be well to apply a bandage tightly from below upwards, when the patient is under chloroform, so that the limb to be removed may contain even less than the usual amount of blood.

In cases in which the tourniquet is inapplicable, or needless, digital compression must be trusted to for preventing hæmorrhage during the operation. The strength of the assistant on whom this duty devolves, is often early exhausted by unnecessary exertion; for the current through an artery lying over a bone, or some other resisting texture, is completely arrested by a very moderate amount of pressure directed exactly to the proper part.

Amputations in the upper extremity.

The upper limb, independently of its smaller size, involving less shock to the system from the operation, is more favourably circumstanced for amputation than the lower, in consequence, apparently, of its possessing a better vascular supply and superior vital power. Thus, to take away the arm at the shoulder-joint, is a much safer proceeding than to cut off a leg below the knee, even though a larger wound be inflicted, and a larger portion of the body removed, in the former case than in the latter.

The particular amputations in the upper extremity will be most conveniently considered in the order in which they occur from below upwards. The distal phalanges, though very liable to injury and disease, rarely require amputation; for the removal of crushed portions of bone in the former case, or exfoliation in the latter, will generally leave a useful end to the finger. If it be wished, the phalanx may be readily taken away by opening the joint across its dorsal aspect, and, after getting the knife round the base of the bone, forming a palmar flap, by cutting from within outwards. Or the palmar flap may be first cut by transfixion; and this being held up by an assistant, the operation is completed by cutting straight through the articulation. If the whole distal phalanx be crushed, amputation through the second phalanx will be best performed by cutting two rounded lateral flaps from without inwards, and dividing the bone with pliers.

Removal of the entire finger is preferable to leaving the first phalanx by itself, which, besides being unseemly, would be a mere incumbrance, except in the index finger; and even there it is of service only in some few handicrafts. For the middle, or the ring finger, the operation is best performed according to the following definite rule. The adjoining fingers being held aside by one assistant, while another compresses the radial and ulnar arteries, the Surgeon cuts from the prominence of the knuckle in a straight line towards the middle of the web on one side; but just before reaching the web carries the knife inwards to the fold between the finger and the palm, and, after making a similar incision on the other side, accomplishes the disarticulation. The edges of the skin will be found to meet exactly on approximation of the adjoining fingers, which should be kept tied in that position to avoid disturbing the process of union. Remarkably little deformity results from this operation, so that removal of the head of the metacarpal bone for the sake of appearance is quite uncalled for. If, however, it is at any time necessary on other grounds to take away a portion of the metacarpal bone, this can be readily done by the same method, except that the incisions are made to start from the place on the back of the hand, where the bone is to be divided by the cutting pliers.

The index finger may be removed in a similar manner, care being taken, in making the incision on the side next the thumb, to carry the knife from the point of the knuckle in a longitudinal direction to near the level of the web between the fingers, before sloping it off towards the palm, otherwise the flap will be insufficient to cover the raw surface. A preferable method, however, is to make dorsal and palmar flaps of rounded form, by cutting from the web between the fingers to a point on the opposite side of the articulation at a sufficiently high level to allow the end of the metacarpal bone to be taken off obliquely, with pliers, so as to get rid of what would cause an unseemly prominence. But if it be necessary to remove a considerable portion of the metacarpal bone, the former method, with the dorsal part of the incision extended upwards, will be the best.

Similar rules apply to the little finger, and, in cases requiring it, the whole metacarpal bone may be removed, by commencing the incision a little above the articulation with the *os unciforme,* so as to give space for dividing the ligaments after clearing the bone of the muscles which surround it.

Any portion of the thumb is valuable for opposition to the fingers, but if necessary the whole of it may be taken away by cutting in a curve with the convexity downwards, from the web connecting it with the fore-finger to the opposite side of the joint, both on the dorsal and palmar aspects, raising the rounded flaps, and disarticulating. The whole metacarpal bone may be removed along with the thumb on a similar plan, by entering the knife a little above the articulation with the trapezium, and cutting first longitudinally, and then with a gentle curve to the web, on each side of the bone, then dissecting up the flaps, and dividing the ligaments of the joint.* This operation has been often performed for tumour of the metacarpal bone; but from a case lately published by Mr. Syme, it would appear that under such circumstances a useful thumb may be preserved by excising the bone affected.†

The thumb alone or a single finger being far more useful than any artificial substitute, should always be retained if possible in cases of injury; but as a general rule, when the carpal articulations are opened, the whole hand will require removal. Circumstances would occasionally admit of amputation at the wrist-joint, supposing this a desirable procedure. But of its two alleged advantages over amputation in the fore-arm, viz. the retention of pronation and supination, and a longer stump, the former, supposing such movements of an artificial limb to be desirable, would probably be often prevented by fibrous union between the radius and ulna, while the latter is found by the instrument-makers to encroach upon the space required for adapting the artificial limb. The operation, if desired, may be performed by cutting across the back of the wrist from one styloid process to the other, in a line presenting a slight concavity downwards, in accordance with the form of the articulation, opening the joint on its dorsal aspect, then shaping a rounded flap in the palm, raising it to the joint, and disarticulating. Another method is to cut the palmar flap from within outwards after disarticulation; but the prominence of the pisiform bone prevents this from being satisfactorily accomplished.

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* For removing the thumb or little finger with the metacarpal bone, other modes of operating, somewhat more rapid, but in other respects disadvantageous even when applicable, were recommended before the introduction of anæsthesia. At present it appears only necessary to mention such as are calculated to give the best results.

† Observations in *Clinical Surgery*, p. 38.

Amputation in the fore-arm is best performed by antero-posterior flaps. In front, where the muscles are in larger amount, transfixion may be adopted; but behind, the presence of the two bones prevents this, except near the wrist, where it may be effected, provided the soft parts have their natural laxity, by pinching up the skin, and passing the knife as close to the radius and ulna as possible, when, after the integument has fallen back to its usual position, the extremities of the wound will be placed so far forward that the knife can be introduced through them in forming the anterior flap. But it is probably always well to cut the dorsal flap from without inwards, and to raise it so that it shall consist chiefly of integument, in order that redundancy of muscle and consequent tension may be avoided. The Surgeon standing on the (patient's) left side of the limb, and holding it with the dorsal surface towards him, enters the knife a little to the palmar side of the bone that is the further from him, and cuts through the skin and fat so as to shape a rounded dorsal flap, terminating the incision a little to the palmar side of the nearer bone, where he at once pushes in the point of the knife, so that it may pass in front of the bones and emerge at the place where the operation was commenced, and cuts a fleshy palmar flap from within outwards. He then dissects up the dorsal flap; and, the soft parts being drawn back by an assistant, clears both bones thoroughly about three-quarters of an inch higher up, and applies the saw. The interosseous artery, which is apt to retract beside the unyielding interosseous membrane, must always be secured, as well as the radial and ulnar trunks; and if the median or ulnar nerve is exposed in the palmar flap, it should be shortened with scissors, to prevent the occurrence of painful symptoms as the stump heals. For preventing hæmorrhage during the operation, it is as well to apply a tourniquet to the arm, as the free arterial anastomosis in the upper limb may cause bleeding in spite of effectual digital compression of the brachial vessel.

There is no objection to amputation at the elbow-joint, in cases adapted for it. The most eligible plan is to cut a large anterior flap from within outwards, after transfixing the partially-extended limb in front of the joint, bearing in mind that the line of the articulation is oblique to the axis of the humerus, and is considerably further below the internal than the external condyle. The flap being then held up by an assistant, the points of transfixion are connected posteriorly by a semicircular stroke of the knife, which, besides dividing the integument, probably detaches the radius, and a few touches with the point of the instrument will sever the connexions of the ulna. The assistant should keep the skin of the back of the arm drawn upwards during the operation.

Amputation of the arm presents a good example of the double-flap operation by transfixion. The point of the knife being entered at one side of the limb, avoiding the site of the brachial vessels and nerves, is pushed on in front of the bone; and then, by slightly raising the handle, is made to emerge at a place exactly opposite. The anterior flap is then cut with a brisk sawing movement of the instrument, which is first directed longitudinally for a short distance, and then turned gradually towards the surface, and brought out perpendicularly to the integument. The flap is now lightly raised by the assistant, without any traction, for this would interfere with transfixion behind the bone, which is effected through the extremities of the wound already made, and the posterior flap is cut like the anterior. The assistant now retracts the flaps firmly, when a circular sweep of the knife exposes the bone about an inch above the angle of union of the flaps, and another similar turn of the instrument prepares it for the application of the saw. The edges of the wound meet accurately when brought together, producing a symmetrically rounded stump.

Amputation at the shoulder-joint is an operation which yields very satisfactory results, as was strikingly shown by the experience of the late Baron Larrey, who, during the wars of the first

Napoleon, saved ninety out of a hundred cases, in spite of the very unfavourable circumstances of military practice.*

Of the various methods that have been proposed, that of Lisfranc is the most expeditious. The arm being raised so as to relax the deltoid, the point of a long-bladed knife is introduced about midway between the coracoid and acromion processes, and thrust round the outer side of the joint till it comes out within the posterior fold of the axilla (or, if the left limb be the subject of operation, the direction of transfixion is reversed), when a large muscular external flap is rapidly cut; and this being held up by an assistant, and the arm drawn downwards and forwards, the joint is opened by cutting firmly upon the head of the bone,† which is then raised from its socket so that the knife may be passed round it, and carried downwards along the inner surface of its neck and shaft, followed by the other hand of the assistant, which grasps the tissues that lie between the track of the instrument and the axilla, so as to prevent bleeding from the main artery, when it is divided in the completion of the short internal flap.

This operation, however, is rarely available in practice. Its satisfactory performance requires the leverage of the humerus, which is generally broken in cases of injury demanding removal of the limb, in which also the parts necessary for the large external flap are often encroached on; and in tumour of the bone, which is the other affection that most frequently calls for amputation in this situation, transfixion becomes impossible.

On the other hand, Larrey's mode of operating, by lateral flaps of equal size, proved almost always applicable in his cases of gunshot wound, while it was as secure against hæmorrhage as that of Lisfranc. Thrusting the point of a knife of moderate length down to the bone immediately below the acromion process, Larrey first made a longitudinal incision about two inches in length, from the extremity of which he cut in a curved line at each side of the limb to the fold of the axilla; then dissected up the flaps so as to expose the articulation completely, a finger of an assistant being placed upon the divided circumflex artery; and, having severed the connexions of the head of the humerus, passed the knife round it, and kept the instrument close to the inner side of the bone, till, turning the edge towards the surface, he last of all divided transversely the tissues intervening between the axillary folds, containing the artery, previously commanded by the hand of the assistant following the knife.*

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* *Mémoire de Chirurgie Militaire*, par Le Baron D. J. Larrey, tom. iv. p. 434.

† Strictly speaking, this is Dupuytren's modification of the method of Lisfranc, who depressed the arm at the commencement of the operation, and opened the joint during the transfixion; but this was a less easy proceeding, though shorter by a few seconds in very expert hands.

This operation is improved by dividing the structures between the folds of the axilla obliquely, as part of the internal flap, the lower portion of which is reserved to be cut from within outwards, at the conclusion of the operation: the result being two precisely similar semilunar flaps, meeting above at the acromion and below at the posterior fold of the axilla, adapted for immediate union throughout their length, and presenting as small a wound as is consistent with an efficient covering.

When the bone is broken near the joint, it will be found useful to adopt Mr. Syme's expedient of introducing the finger into a longitudinal wound in the capsule, for the purpose of drawing down the head of the bone so as to gain access to its attachments. In some cases of tumour it may be necessary to raise all the soft parts, including the axillary vessels, from without inwards; when hæmorrhage must be restrained by compression of the subclavian artery over the first rib, by the thumb of an assistant pressed down behind the collar-bone.

Sometimes it may be best to make a large superior flap, cut from without inwards, containing the whole width and chief length of the deltoid muscle; but circumstances will often arise in which no regular rule can be followed, and the parts that happen to be sound must be turned to the best advantage, according to the judgment of the operator. Even when a large raw surface is left, the granulating process will complete the cure, as is well illustrated by some of Larrey's cases, which terminated satisfactorily after extensive loss of the soft parts of the shoulder and removal of portions of the scapula.

Amputations in the lower extremity.

The distal phalanx of the great toe may be removed in the same way as that of a finger. When one of the smaller toes is in a condition requiring amputation at all, it must be taken away entirely, by an operation exactly similar to that for a finger; but it must be borne in mind that the articulation with the metatarsal bone, which is the starting point for the incisions, is much further behind the web than the corresponding joint in the hand, in proportion to the size of the digit.

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* During one period of his practice, he formed the lower parts of the flaps by transfixing from the end of the longitudinal incision to the borders of the axilla, and cutting from within outwards; but the method given in the text is that to which he ultimately gave the preference. See Larrey's *Clinique Chirurgicale*, 1829, p. 563.

When the whole great toe is removed, the prominent part of the head of the metatarsal bone must be cut off with bone-pliers, as it would prove inconvenient if left. In amputating the great or little toe, together with the whole metatarsal bone, it is best to proceed as in the analogous operation for the little finger, the incision being commenced on the dorsum of the foot, about a quarter of an inch behind the articulation with the tarsus, and carried longitudinally to near the metatarso-phalangeal joint, where it bifurcates to embrace the root of the toe. The knife, which should be a strong one, is then applied with a short sawing action close to the metatarsal bone and its articulation with the toe, so as to clear them completely, and the ligamentous attachments of the base of the bone are lastly divided with the point of the instrument. In the case of the great toe, it is especially important to keep the knife well under command, and avoid thrusting its point deeply into the sole; for this, besides inflicting unnecessary punctures, may wound the plantar artery at a part difficult of access. This mode of removing the great or little toe and its metatarsal bone, though not so rapid as that of dissecting up a flap from the side of the foot, then cutting between the toe to be removed and the adjoining one, and disarticulating, has the great advantage of avoiding any scar in the sole.

If more metatarsal bones than one require removal, the incision must be begun in the same way, but made to include the roots of all the toes concerned, so as to form a dorsal and a plantar flap; and even in case of caries in the articulation between the tarsus and metatarsus at one side, a useful foot may be left after taking away the bones affected, by means of a similar incision commenced further back.

The separation of the whole metatarsus from the tarsus is an operation seldom called for; but it is evident, from the account given by the late Mr. Hey of Leeds,* who introduced it, that it affords excellent results. When the state of the soft parts permits, the ends of the exposed tarsal bones should be covered with a long flap from the sole, turned up to unite with the dorsal integument, cut very short; so that the cicatrix, being on the upper part of the foot, may be out of the way both of pressure in walking and of contact with objects in front of it. In performing the operation, it must be remembered that the tarso-metatarsal articulations are not in a regular line, but that the base of the second metatarsal bone is locked between the first and third cuneiform bones, of which the former is the more prominent, and is connected laterally with the second metatarsal by a very strong interosseous ligament. To divide this ligament, Lisfrane adopted the plan of thrusting an amputating knife obliquely downwards and backwards between the first and second metatarsal bones into the substance of the sole, the tissues of which served as a fulcrum, supporting the point of the instrument, when its edge was urged forcibly between the bases of the bones by pushing the handle backwards. This, however, is a needlessly rough proceeding; for by pressing firmly back between the bases of the bones a strong and short knife, such as ought to be used for the rest of the operation, the ligament may be cut without difficulty; after which all the articulations are readily separated by scratching through the dorsal and other ligaments with the point of the knife, while the metatarsus is strongly depressed.

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* Hey's *Observations*, p. 555.

The secret of facility in the operation lies in hitting the line of the articulations; but this is readily enough done by finding first the joints of the first and fifth metatarsal bones, and bearing in mind that the others lie in a line between them slightly convex forwards, interrupted by the recession of the second bone. The prominence of the base of the fifth metatarsal indicates the situation of its joint, and, if the parts be in natural condition, the articulation of the first metatarsal with the first cuneiform can also be felt. Should inflammatory thickening obscure the position of the latter, it might be well to measure the distance of the corresponding joint from the internal malleolus on the sound foot; or assistance may be derived from the circumstance that the joint lies midway between the malleolus and the metatarso-phalangeal articulation.

These points having been precisely ascertained, the Surgeon grasps the fore part of the sole with his left hand, placing the tip of the forefinger at one of the joints, and the thumb at the other, to mark their position, and cuts firmly across the dorsum of the foot in a line slightly convex forwards, a little anterior to the articulations, taking care that the incision commences and ends fairly in the sole. He then opens the joints of the first and fifth metatarsal bones, so as to insure finding the line of the articulations afterwards, and next shapes a long plantar flap by an incision extending from the extremities of that already made along the sides of the foot and roots of the toes, dissects up the flap from the bones, and completes the disarticulation in the manner above described.

When the anterior part of the sole is unsound, a shorter plantar flap and a proportionately longer dorsal one may be made, as recommended by Sir Astley Cooper.*

Sometimes the proceeding may be greatly simplified by sawing through the metatarsal bones a little anterior to their bases, and so avoiding disarticulation altogether. This method would probably have another advantage, from making the stump of the foot longer, and therefore a more effectual lever for opposing the muscles which act upon the calcaneum through the tendo Achillis; for experience has shown that when the foot is much shortened, the heel is apt to be drawn up, so as to cause the end of the stump to point more and more towards the ground, producing lameness or entire inability to walk. This has been noticed especially after Chopart's amputation through the tarsus, which is consequently an undesirable operation, even in cases of injury; while in caries it is further objectionable, because the part of the tarsus left behind, though apparently sound at the time, is apt to become affected with the same disease at a later period.

If it be wished, however, Chopart's operation may be performed on the same principle as Hey's, by making a very short dorsal flap, and a plantar one reaching to the balls of the toes, to cover the exposed anterior surfaces of the astragalus and os calcis. The articulation between them and the navicular and cuboid bones will be found in a line running across the foot, through a point midway between the external malleolus and the base of the fifth metatarsal bone.

In the amputation at the ankle devised by Mr. Syme, the bones of the leg are divided just above the bases of the malleoli; a covering for the osseous surfaces being provided from the integument of the heel, fitted by the character of its epidermic investment and subcutaneous cushion, for bearing the weight of the body.

Hence the end of the stump becomes as capable of sustaining pressure as the natural sole; and when the deficient spring of the arch of the foot is compensated by some elastic material contained in a very simple boot, the limb proves nearly as useful as in its normal condition. At the same time, the parts likely to originate carious disease are completely got rid of; so that this operation is calculated to supersede entirely that of Chopart, besides taking the place of amputation of the leg in the majority of the cases formerly supposed to demand it.

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* *Surgical Lectures*, edited by Tyrrell, vol. ii. p. 432.

The operation should be performed as follows. Provision being made against hæmorrhage from the anterior and posterior tibial arteries, by the pressure of the thumb and finger of an assistant, placed respectively on the middle of the fore part of the limb and behind the tibia, about two inches above the joint, or by a tourniquet applied over two rollers occupying those situations, and the foot being held at right angles to the leg, the Surgeon puts his left hand behind the heel, with the finger and thumb on the places where the incisions are to commence and terminate; these being the tip of the external malleolus and the point exactly opposite on the inner side, *i. e.* not at the tip of the internal malleolus, but considerably below and behind it. With a knife, short and strong both in blade and handle, he now cuts down to the bone across the sole from one of these points to the other, in a plane not quite vertical, but sloping slightly towards the heel, especially when that part is unusually prominent; and then, extending the foot, joins the horns of this incision by another running as straight as possible across the front of the ankle. He next dissects up the posterior flap from the os calcis, keeping the edge of the knife close to the bone with the guidance of the left thumb-nail, till the point of the calcaneum is fairly turned, when he proceeds to open the joint in front, divides each lateral ligament with a stroke of the knife applied between the malleolus and astragalus, and completes the removal of the foot by severing the tendo Achillis. He then prepares the bones of the leg for the application of the saw; taking care, when cutting behind the tibia, to keep close to its surface, from which the posterior tibial artery is separated only by a little loose cellular tissue; and lastly, he takes off the malleoli along with a thin slice of the intervening part of the tibia, sawing perpendicularly to the axis of the limb.

It is a common mistake to make the inner end of the incision at the internal malleolus, instead of opposite the extremity of the outer one. This has two bad effects: it renders the flap unsymmetrical, and, what is far worse, it makes it unnecessarily long, and thus introduces an element of difficulty and risk into an easy and safe operation. For when the incision is carried forwards to the hollow of the foot, it becomes a most troublesome task to turn back the integument over the prominence of the heel; and the knife being thrust the operator knows not where, the subcutaneous tissue on which the skin depends for its nourishment is punctured and scored, and perhaps the point of the instrument appears occasionally through the skin itself, while the flap is subjected to violent wrenching in the effort to draw it back over the bony projection. Under such a combination of unfavourable circumstances, it is but natural that it should slough.

On the other hand, when the flap has been made as above recommended, it applies itself with perfect uniformity to the surface it is designed to cover, and has no disposition to shift to one side in the after progress of the case; and every stroke of the knife by which it is raised being made under the eye of the Surgeon, without any forcible traction, it is as little liable to slough as any other portion of integument with an equally broad base and an equally rich vascular supply. Even the integrity of the posterior tibial artery, though desirable, is by no means essential, provided the rest of the subcutaneous tissue has been left uninjured. Many persons, in discussing the merits of this operation, seem to assume as an axiom, that sloughing of the flap must occasionally take place; but I am persuaded from very extensive experience, especially in Mr. Syme's practice, that, if the skin of the heel be sound, such an occurrence will always be the fault of the operator. Traumatic cases, in which the integuments are thinner than in chronic disease, are considered the most unfavourable; but though I have had occasion to perform the operation in several cases of this kind, I have never met with the slightest sloughing. The last instance was that of a young man who, lying in a state of intoxication with his feet upon a rail, had the fore parts of both crushed by a train, and I amputated both at the ankle. The latest intelligence that I have received of him is that he was able not only to walk but to run, and even to "dance the Highland fling."

Hence the various modifications of the original method that have been suggested, though commonly discussed chiefly with reference to a fear of sloughing, must be judged of entirely on other grounds. Thus the plan introduced by the late Dr. Richard Mackenzie of Edinburgh, of making the base of the flap at the inner side, that it may have a more free supply of blood from the posterior tibial artery, is not to be regarded as a substitute for the simpler method of a posterior flap; yet it proves useful in case of unsoundness of the integument on the outer side of the heel; and it is probable that an external flap might be made with equal advantage if the internal aspect of the limb were affected.

The operation of Professor Pirogoff of Petersburg, in which the posterior part of the os calcis is sawn off and turned up as part of the flap to unite with the cut end of the tibia, has the disadvantage that it tends to direct towards the ground the thin skin of the back of the heel instead of the thick cushion of the sole; while the increased length of the stump which it produces is rather objectionable than otherwise; for, with the original operation, the space afforded for the artificial foot is not more than the maker finds convenient.

A short flap, besides being more easily and safely made, is preferable to a long one, because it presents a smaller cavity for the accumulation of discharge. To prevent any inconvenience at all from this source, an opening may be made through the thin skin at the back of the heel, as has been recently recommended by Mr. Syme;* but, it need scarcely be added, the unintentional occurrence of a " button-hole," sometimes spoken of as advantageous, is a sure sign of most faulty operating. Wire stitches are very useful in preventing the necessity for early strapping to keep the flap in its position. The stump should be lightly dressed, upon general principles.

In cases which do not admit of Mr. Syme's operation, amputation immediately above the ankle should be performed if possible, in preference to that at " the seat of election," a little below the knee; for although the use of the knee-joint may be retained even with a very short stump, the longer one gives greater command over the artificial limb, and the operation involves less risk to life.

Different methods may here be employed. One mode is to make a short semilunar anterior flap cut from without inwards, and a larger posterior one formed by transfixing behind the bones and cutting downwards and outwards, the saw being applied a little above the bases of the flaps; or antero-posterior skin-flaps of equal length may be made, and the bones divided somewhat higher up. Or again, the modified circular operation† is applicable in this situation.

But in order to attain the benefits of a stump capable of bearing part of the weight of the body on its extremity,‡ it would probably be best to make a large rounded anterior flap, to unite with the posterior integument divided transversely, and to saw the bones at a considerably higher level. The result would then resemble that of amputation at the ankle, in having the cicatrix out of the way of pressure and in the fulness of the covering provided, though differing from it entirely in the quality of the tegumentary cushion.

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* *Observations in Clinical Surgery*, p. 48.

† See p. 59.

‡ See p. 60.

In performing the operation, two longitudinal incisions should be carried along the posterior edges of the tibia and fibula for a distance equal to the diameter of the limb, and these should be joined inferiorly across the front of the ankle in a curved line, with the convexity downwards, and then connected superiorly by a transverse stroke of the knife, dividing all the tissues behind the bones. In dissecting up the anterior flap, it may be well, in order to insure its vitality and render it more substantial, to raise along with the skin the muscles lying between the bones, as is done by Mr. Teale in forming his long rectangular flap.* Mr. Teale has also pointed out, that when the attachments of those muscles to the bones have been divided with the knife, their cellular connexions with the interosseous membrane are readily separated with the finger, so as to avoid any risk of wounding the anterior tibial vessels.† The soft parts being then retracted by an assistant, the bones should be cleared an inch higher up for the application of the saw.

In amputating through the calf, with the same object in view, the operation should be similar; except that it will not be necessary to make the anterior flap longer than about two-thirds of the diameter of the limb, for reasons that have been before considered;‡ but a posterior flap of half the length of the anterior one will be required, and should be formed by dividing the skin and fat by a semicircular turn of the knife, and dissecting up the integument before cutting the sural muscles.

The modified circular operation employed by Mr. Syme for this situation is executed as follows: the knife being entered at one side, about a hand's-breadth below the anterior tuberosity of the tibia, is drawn across the front of the limb in a curved line, with the convexity downwards, to the opposite point on the other side, dividing merely the skin and fat; and a similar incision having been made posteriorly, the semilunar flaps of skin are raised, and the dissection of the integument is continued to about an inch or an inch and a half above their angle of union, when the sural muscles are divided about half as low as they are exposed, in order to allow for their contraction, which brings them to a level with the rest of the muscles after the latter have been cut where the bones are to be sawn, which is as high as the integuments have been retracted.*

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* Teale on *Amputation*, p. 41.

† *Medical Times and Gazette*, July 6th, 1861.

‡ See p. 63.

Except that the cicatrix lies where it would be subjected to pressure if the end of the stump were made to rest on the artificial limb, this method is preferable to any other, on account of the smallness of the wound and the accuracy with which its edges meet "without either straining or redundance."

The old flap-operation, in which a large muscular mass from the calf is turned up to cover the bones, though more rapid, is, as we have seen,† an undesirable proceeding: it is, however, still employed by many Surgeons; being very readily accomplished by drawing the knife in a segment of a circle across the front of the leg from one bone to the other, transfixing behind them, and cutting first downwards and then gradually outwards, next dissecting up the anterior flap of integument, and clearing and dividing the bones at the level of its base.

In order to avoid splintering the fibula, it is best to saw both bones at the same time, and to finish the fibula before the tibia. The sharp angle of the spine of the tibia, being apt to cause ulceration of the skin over it, should be removed; and the most convenient way of effecting this is to commence with sawing obliquely for a short distance from a point about half an inch above the place where the bones are to be divided transversely.

For restraining hæmorrhage during amputation of the leg, the tourniquet should be applied round a roller placed between the hamstrings.

Amputation at the knee-joint is an operation which has not met with much favour. Within the last few years, however, accounts have appeared in the medical journals‡ of cases in which it has been performed with good result at some of the London hospitals, by raising a large anterior flap from the upper part of the leg, opening the joint, and cutting a shorter posterior flap from within outwards, the patella being retained in the anterior flap. It is stated that the end of the stump supported the weight of the body unusually well, as might have been anticipated, provided all went on favourably in other respects, from the extensive surface over which the pressure is distributed, and also from the integument on which the patient rests having been habituated to similar treatment in kneeling.

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* Syme's *Principles*, p. 148.

† See p. 59.

‡ *Lancet*, November 7th, 1857; April 24th and December 11th, 1858; and April 30th, 1859.

The thigh is differently circumstanced for amputation in different parts. Near the knee we have seen* that to form two flaps by transfixion is objectionable, on account of the tendency to protrusion of the bone, caused by the posterior muscles divided so far from their origin at the pelvis; but the use of the tourniquet enables us to adopt preferable methods, without reference to the time they occupy. In the upper part of the limb, on the other hand, the muscles being all cut short, this operation has no longer the same objection, and the rapidity with which it is executed becomes a matter of importance, since manual compression, which is then trusted to for restraining hæmorrhage, though it may command the direct stream through the main trunk, cannot, at least in a muscular limb, effectually prevent a recurrent flow through anastomosing branches.

In the modified circular operation, as applied to the lower third of the thigh, semilunar skin-flaps are cut in the same manner as below the knee; but as there is much greater tendency to protrusion of the bone in the present case, the soft parts are retracted to a much greater extent before the saw is applied. The dissection of the integument from the muscles is carried two inches above the bases of the flaps, when the posterior muscles are cut long, and the anterior ones as short as possible; after which the muscles are all drawn up by means of a retractor (for which a handkerchief will answer on an emergency), and the bone is cleared and divided two inches higher up.†

But in accordance with the principles previously explained,‡ the effects of the contraction of the posterior muscles may be got rid of as effectually, and the cicatrix, at the same time, be placed out of the way of pressure from the artificial limb, by making a large muscular anterior flap, and a short posterior one composed of integument, in the way recommended for amputation through the calf, and retracting the muscles two inches before sawing the bone. The anterior flap should be cut from without inwards, both for the sake of shaping it with precision, and also to avoid redundancy of muscle.

In other parts of the limb, even although the tourniquet cannot be used, the same method might probably be employed with advantage, as it is much more quickly executed than the circular operation, and also avoids the risk of tension from excess of muscle which attends transfixion; but if the latter mode be preferred, the flaps should be cut as in the corresponding operation on the arm, except that the anterior one may be made longer than the posterior, in order to throw back the cicatrix, and the bone should be divided about an inch and a half above the angle of union of the flaps.

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* See p. 60.

† Syme's *Principles*, p. 149.

‡ See p. 63.

In amputation of the thigh the flaps should always be antero-posterior, because the flexor muscles being no longer counteracted by the weight of the limb, the bone tends to become tilted forwards, so that its extremity would be apt to show itself in the anterior angle of lateral flaps.

The tourniquet must be applied as high up as possible in the thigh, otherwise it would interfere seriously with the retraction of the soft parts, and the roller must lie over the femoral artery. When digital compression is resorted to, the hands should grasp as much of the circumference of the limb as possible, while the thumbs are placed over the vessel, as it lies on the pelvis, midway between the symphysis pubis and the iliac spine.

Amputation at the hip-joint, though a most formidable proceeding, has, nevertheless, been attended with a sufficient amount of success to render it justifiable in circumstances that would otherwise be desperate.

The easiest and most rapid method is to form a large anterior flap by transfixion, disarticulate, and cut a short posterior flap, also from within outwards. The thigh being somewhat flexed, to relax the soft parts of the front of the limb, the point of a knife with a blade about a foot long is entered midway between the anterior-superior spinous process of the ilium and the great trochanter, supposing the left side operated on, and passed in front of the bone till it emerges near the tuberosity of the ischium, or in the opposite direction if it be the right limb. The knife is then carried longitudinally with a rapid sawing movement, followed by the fingers of one hand of an assistant, which are introduced into the wound so as to compress the femoral artery securely between them and the thumb, previously placed over it in the groin, his other hand being employed to lift up the large anterior flap as soon as it is completed. The limb being now extended and abducted, the Surgeon opens the capsule of the joint by cutting firmly upon the head of the bone; and as this starts from its socket he divides the round ligament and the posterior part of the capsule, and lastly, the thigh having been adducted to draw the trochanter down out of the way of the knife, he completes the severance of the limb by cutting downwards and backwards through the muscular mass at the back of the thigh.

Attention is now at once directed to the bleeding vessels of the posterior flap, fed by the internal iliac, which are covered in the first instance with a folded cloth, or what is better by the tips of the fingers of an assistant; and when they have been tied, the femoral trunk and any of its branches which may require it are secured in the anterior flap.

When the state of the parts does not admit of a long anterior flap, the posterior one may be lengthened without increasing the hæmorrhage, by shaping it at the commencement of the operation by an incision extending only through the skin and fat, and dissecting up the integument to the part where the muscles can be conveniently divided from within outwards, after the anterior flap has been formed and disarticulation effected in the usual way.

Should tumour of the bone render transfixion impossible, it will, I believe, be found advantageous to adopt an expedient lately suggested to me by a very interesting case related by an American Surgeon (whose name I regret being unable to give), who disarticulated at the hip-joint, after dissecting up the soft parts from a large fibro-cartilaginous mass, with very trifling hæmorrhage, having the aorta compressed by an assistant; and the patient made a good recovery.

For the purpose of compressing the aorta with precision and efficacy, I have had a large horse-shoe clamp constructed, with one end expanded and covered with soft material for application to the back, while the other end receives a screw, which presses down an appropriate pad. This being gradually screwed down, at a point a little above and to the left of the umbilicus, I find that the pulsation in both femoral arteries can be completely abolished, without any serious uneasiness or unpleasant consequence.

JOSEPH LISTER.

ANÆSTHETICS.

TO prevent or diminish pain in surgical operations is an object so desirable, that many in various ages in the history of Medicine have sought to attain it, either by means of narcotic drugs designed to act on the body generally, or by compressing or otherwise locally affecting the nerves of the part concerned.*

The first really valuable suggestion, however, was made in the year 1800 by Sir Humphrey Davy, who, having himself experienced relief from pain when breathing nitrous oxide gas, threw out the hint that it might probably be employed with advantage to produce a similar effect in surgical practice.†

The same idea occurred, after the lapse of nearly half a century, to Dr. Horace Wells, a dentist in Hartford, Connecticut, who, in 1844, underwent the extraction of a tooth without pain after inhaling the gas, and gave it with satisfactory results to several of his patients; but he soon after found the practice so uncertain that he abandoned it entirely.‡

About the same period, Dr. W. T. G. Morton of Boston, in America, who had previously been a partner with Wells, but did not, as he informs us, receive any suggestion from him, became possessed with the desire of discovering an efficient anæsthetic, and commenced a series of experiments upon himself and the lower animals, which at last resulted in his extracting a tooth painlessly from a patient, to whom he had administered the vapour of sulphuric ether by inhalation. This was on the 30th of September 1846.§ Soon afterwards he publicly exhibited his method at the Massachussets General Hospital; and thenceforward anæsthesia in surgery was an established blessing to mankind.

Sulphuric ether is still extensively used as an anæsthetic in America; but in Europe chloroform is generally preferred to it.

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* For much curious information regarding the history of this subject, the reader is referred to the work of the late Dr. Snow on *Anæsthetics*.

† *Chemical Researches*, p. 556.

‡ *Statements of William T. G. Morton, M.D., on his claim to the Discovery of the Anæsthetic Properties of Ether, &c.*, Washington, 1853, pp. 42, &c.

§ Dr. Morton's *Statements, &c.*, pp. 45, &c.

Disguised under the name "chloric ether," in which it exists diluted with spirit of wine, this agent was the subject of Dr. Morton's first experiment upon himself;* and it was used in the same form at St. Bartholomew's Hospital, in preference to sulphuric ether, by Mr. Lawrence in the summer of 1847.† In the autumn of that year Dr. Simpson, who was engaged in a series of experiments with various narcotic vapours, employed for the first time the active principle of chloric ether, at the suggestion of Mr. Waldie of the Apothecaries' Hall of Liverpool;‡ and finding that the pure chloroform was more potent than sulphuric ether, yet caused less bronchial irritation, while its odour was more agreeable and its inferior volatility rendered its exhibition more easy,§ he zealously recommended it to the profession, and it has since been generally employed throughout Europe.‖

The effects produced by chloroform are such as to fit it remarkably for the purposes of the Surgeon. Like most narcotics, it tends to cause, after temporary excitement, suspension of the functions of the nervous centres, but affects them not simultaneously, but in a certain order; and the brain is the first to show loss of power in failure of sensation and voluntary motion. If this were all, anæsthesia would be a questionable boon, as the work of the Surgeon would be interrupted and often marred by involuntary struggles on the part of the patient. But very soon the spinal cord also is subdued, and the reflex functions of the cerebro-spinal axis are abolished so far as concerns the voluntary muscles, which consequently lie perfectly relaxed and passive, better suited for operative purposes than the most resolute will could render them. To this, however, there is one remarkable exception, viz. that the parts concerned in the respiratory movements remain active; and the same is the case with the sympathetic ganglia of the heart. In other words, when the administration of chloroform is carried to a certain point, the nervous system is deprived of such powers as would cause pain to the patient or inconvenience to the Surgeon, but retains intact the faculties essential to life.

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* Op. cit. pp. 45, 46.

† Snow on *Anæsthetics*, p. 20. That chloric ether was employed at St. Bartholomew's Hospital, has been further confirmed by information kindly communicated to me by Mr. Paget.

‡ Snow on *Anæsthetics*, pp. 21, 22; also Dr. Simpson's original pamphlet, *Account of a new Anæsthetic Agent*, &c. p. 6.

§ For operations performed by artificial light, chloroform has another advantage over ether, in the fact that its vapour is not inflammable.

‖ It has been shown by Dr. James Arnott, that a superficial part may be rendered insensible without injury by a freezing mixture of ice and salt; and I understand that for trifling matters this local anæsthetic means is frequently employed in London. The ice, having been finely pulverised and thoroughly mixed with about an equal quantity of common salt, is placed in a piece of muslin and applied for two or three minutes to the skin. See *Lancet*, October 30th, 1858.

There are, however, yet other advantages derived from the inactivity of the cerebro-spinal centre. It seems now clearly established that the cessation of the contractions of the heart in the shock of injury depends upon an action of the brain and cord upon the cardiac ganglia through the medium of the vagus and sympathetic nerves; and chloroform, rendering this action impossible, protects the heart from the indirect effect of external violence. In this way it has diminished the risk of death upon the operating table, and also has overthrown the old rule of deferring amputation in cases of injury till the patient has recovered from the state of collapse; thus shortening the period of mischief to the system from the presence of the mangled limb, and in extreme cases sometimes saving life where it would be hopeless to wait for returning consciousness. Indeed, an amputation performed under chloroform has often the effect of improving instead of lowering the pulse. The most striking instance of this, that has fallen under my notice, occurred in a labourer, whose right arm and thigh had been destroyed by a railway accident, just enough sound tissue being left to admit of amputation through the hip and shoulder joints, which was accordingly performed as a forlorn hope by the Surgeon in charge of the case. The vital powers being in a state of extreme depression, it is probable that without chloroform this severe measure would have killed him outright, but by help of the anæsthetic it was followed by marked improvement of the pulse, which continued for some hours, so as to lead us to entertain hopes of his recovery.

Faintness during the operation, a species of shock, is also got rid of by chloroform; and this, besides its obvious convenience, has the advantage of lessening the chance of secondary hæmorrhage; for the vessels which require ligature declare themselves as such by bleeding, instead of deceptively eluding observation in consequence of the feebleness of the heart and the general arterial contraction which coexist in the state of syncope.

The welfare of the patient is besides greatly promoted by the mental tranquillity arising from the prospect of immunity from suffering, which also induces persons to submit much more readily to the necessary operations, and often to undergo without hesitation treatment which was formerly impracticable because intolerable.

Such being the great benefits conferred by this agent, it is melancholy to reflect that in many parts of Europe, and even of the United Kingdom, it is either withheld altogether or given so scantily as to be nearly useless. This arises from fear inspired by several fatal cases that have occurred. But when I state that Mr. Syme has given chloroform about five thousand times without ever meeting with a death, and that Dr. Simpson's experience, also very extensive, has, so far as I am aware, been equally satisfactory, it is clear that it may be used so as to be practically free from any risk whatever.

How then are the fatal cases to be accounted for? Heart-disease has been supposed to be a common cause of them; and it happens that the only death I ever witnessed under chloroform occurred in a person whose heart proved, on examination, to be extensively affected with fatty degeneration, such as would be regarded as sufficient explanation of sudden death under any circumstances. The particulars of this case, however, presented peculiar features, which lead me to take a different view of the part played by the chloroform from what might at first be assumed. The patient was a man above the middle period of life, affected with cancer of the penis, for which amputation of the organ was to be performed. The gentleman in charge of the chloroform, considering the momentary nature of the operation, purposely abstained from giving it as fully as usual, and had removed the cloth containing it from the face before the operation was commenced. The Surgeon now placed his finger on the patient's wrist, and, having ascertained that the pulse was good, at once effected the amputation almost instantaneously. I observed that the passage of the knife through the member was accompanied by a start of the patient's body; the bandage used to control the bleeding was then removed, but no blood flowed from the arteries; he was found to have no pulse at the wrist; in short he was dead. From these facts we can hardly doubt that death was a consequence of the shock of the operation acting on a diseased heart; and the only question is whether the circumstance that he had taken chloroform promoted that result. From the foregoing considerations, such a thing seems altogether improbable, as we have seen that chloroform protects the heart from the effects of shock. The fact that the patient started proved that reflex action was not abolished in the voluntary muscles, and confirmed the statement of the administrator that the chloroform was imperfectly given. My own impression is, that if it had been pushed to the usual degree, the fatal occurrence would have been averted.

I have given this case in detail because I believe it may be regarded as typical of a considerable class in which death has taken place suddenly at the commencement of an operation with imperfect administration of chloroform, which stands to the fatal event in the relation of an accidental concomitant, or rather a preventive insufficiently used.* A death essentially similar, though more obviously unconnected with chloroform, took place on the occasion when it was intended to have administered it for the first time in the Edinburgh Infirmary; but Dr. Simpson being prevented from attending, the operation was commenced without the anæsthetic, and the patient died suddenly immediately after the first incision. It has been often remarked, that if the original intention had been carried out, chloroform would never have been heard of again in Edinburgh; but it is very likely that the man might then have lived to testify to its benefits.

There is another class of fatal cases in which the use of chloroform seems to have been simply a coincidence, the real cause of death being mental emotion, acting usually upon a disordered heart. Dr. Snow mentions a distinct example of this, where a mere profession of administering chloroform was made, and the patient died of fright;† and I am able to give, from Edinburgh experience, an instance in which chloroform was still more remotely concerned. The late Dr. Richard Mackenzie being called to see a gentleman who had fractured his radius, had some thought of employing chloroform in examining the arm, but, changing his mind, made the necessary manipulations without it. He then proceeded to leave the house; but had not got down the steps leading from the door when he was called back with the announcement that his patient had suddenly expired. Had chloroform been held near the face a few seconds before this occurrence, it would certainly have been blamed, though with manifest unfairness; and a similar injustice seems to have been committed with regard to several cases in which fatal syncope has taken place early in the administration of the anæsthetic, when the brief period of inhalation concurred with the symptoms in showing that the patient was little, if at all, under its influence. A fear of the chloroform itself seems to have been the exciting cause in some of these cases; and one reason why no such instance has occurred in the Edinburgh Infirmary, is probably the unlimited confidence reposed in this agent by the inmates of that institution.

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* An observation made several years ago by Mr. Bickersteth, of Liverpool, has an interesting bearing upon this class of cases. He noticed on three occasions in amputation of the thigh that the pulse stopped suddenly at the moment the knife entered the limb, but recovered itself in a few seconds. The patients were under the influence of chloroform; but as Mr. Bickersteth never observed the same thing again, though he watched the pulse carefully at the same period in a great number of capital operations under chloroform, it seems probable that the anæsthetic was not administered to its full degree in those instances. (See *Monthly Journal of Medical Science*, September 1853.)

† Snow on *Anæsthetics*, p. 201.

It might, perhaps, have been expected *a priori* that chloroform, in the early or exciting stage of its operation, would act upon a diseased heart like mental emotion, and cause irregularity or cessation of its contractions; but this does not seem to be the case. Judging from my own experience, I should say that it tends rather to remove intermission or irregularity of the pulse; and on the whole I believe that chloroform, by preventing shock and mental effort during the operation and anxiety before it, is in reality a great source of safety in heart-disease.

Yet it is a common belief that, in the majority of the fatal cases, death resulted from a weakening effect produced upon the heart itself by the narcotic; and that chloroform may, under some circumstances, act as a direct sedative upon the heart, was clearly shown to me eight years ago by the following occurrence. An eminent London physician, desirous of making some experiments upon the heart, selected a young donkey for the purpose, and requested me to maintain artificial respiration, which was done by means of a large pair of bellows connected with a tube tied into the trachea, the animal having been previously put under the influence of chloroform. The chest having been opened, the investigation was continued for a while, when the creature began to exhibit signs of returning consciousness. To avert this I removed the bellows, and poured into them a considerable quantity of chloroform, and resumed the artificial respiration with energy for a short time, the natural respiratory movements meanwhile continuing; when suddenly the heart, which lay exposed before us, ceased to beat, and refused to contract again even when its muscular substance was pinched, which showed that its nervous apparatus was paralysed.

This was no doubt caused by the air becoming highly charged with chloroform in passing over the extensive evaporating surface presented by the interior of the bellows. For it had been before shown by Dr. Snow, from experiments upon the lower animals, that an atmosphere containing more than a certain percentage of the narcotic vapour stops the heart before breathing ceases; whereas the reverse occurs when the chloroform is more diluted.* Hence, with the view of preventing fatal syncope, Dr. Snow contrived an inhaler for regulating the amount of chloroform vapour in the inspired air; and used it in upwards of four thousand cases, of which only one was fatal, and even that seemed to be so independently of the chloroform. Finding his ingenious efforts crowned with such success, and charitably supposing that all were as careful as himself, he concluded that fatal cases in the hands of others could result only from a faulty method of administration; and assuming that when chloroform is given from a folded cloth it is apt to be in too concentrated a form, he attributed most of the deaths that have occurred to paralysis of the heart from this cause.

But the cloth being the means which has been used from the first in Edinburgh, with success even superior to Dr. Snow's, I have been long satisfied that his argument was fallacious; yet as his special devotion to the subject, and the valuable facts which he has communicated regarding it, render his opinion influential, I have thought it worth while to subject a matter of such great practical importance to experimental inquiry; and, about the usual quantity of the liquid being employed, I find that, so far from the amount of chloroform given off from the cloth being in dangerous proportion to the air inhaled, the whole quantity which evaporates from the under surface, even when the rate is most rapid, viz. just after the liquid has been poured upon it, is below Dr. Snow's limit of perfect security against primary failure of the heart.†

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* I have noticed, however, that different animals differ in their susceptibility to chloroform. Thus, frogs or mice may be kept for any length of time under its influence; but bats are very apt to die when treated in exactly the same way.

† The experiments were performed in the following manner. A cloth, similar in all respects to what would be used in practice, was supported upon a light wire frame-work, and suspended at a little distance from the floor by a thread, connected with one end of the beam of a balance, projecting over the edge of the table on which it stood. The weight of the cloth having been ascertained, a weighed quantity of chloroform, corresponding to fl. ʒjss., which is about the amount commonly used, was poured upon the middle of the lower surface of the cloth, which was then allowed to hang close above my face, so that I might breathe fully upon it, while inspiration was performed through a long India-rubber tube to avoid inhaling the chloroform vapour. The amount lost by the cloth was indicated by the weights in the scale at the other end of the beam. At the commencement of an experiment the weight was made a few grains less than the sum of the weights of the cloth and chloroform together, and an assistant noted the second when the scale with the weights in it came to preponderate; then removed

But, considering the great diffusibility of the vapour, and the large amount blown away in expiration, it is evident that only a small proportion of that which comes from the lower surface of the cloth really enters the lungs. Were it otherwise, it would be extremely dangerous to give chloroform with the cloth to infants; for as they inhale but a small amount of air, they would then breathe the vapour in a very concentrated state; yet all are agreed that infants are peculiarly favourable subjects for chloroform. In truth, the quantity dissipated into the surrounding air when the cloth is used involves considerable wastefulness in this means of administration, which is its only disadvantage as compared with an inhaler; but this is abundantly compensated by its greater simplicity, and consequent greater safety. For any apparatus which has the effect of preventing the free access of the atmosphere must be liable to operate in the same deadly manner as the bellows in the case above related; and, even when constructed upon the best principles, will

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ten grains so as to allow the scale to rise, and again watched the time of its descent; and repeated this process several times, thus obtaining a very accurate record of the rate of alteration in the weight. The lower surface of the cloth, which was made slightly concave, was circumstanced just as in the early period of the administration of chloroform, except that the inspired air was drawn from a distance. Inspiration does not, however, materially affect the rate of evaporation, as was found by experimenting with a cloth arranged above the mouth of a tube into which air was drawn by an appropriate apparatus. Allowance being made for the slight gain in weight that the cloth would obtain from absorbing the moisture from the breath, the amount of chloroform lost from both surfaces together was thus easily determined. In order to ascertain how much escaped from the upper surface, experiments were made with the same cloth, having first the upper and then the under side securely covered with oil-silk, the arrangements being as above described, except that my face was not below the cloth. The quantity given off from the upper surface in a normal atmosphere was thus determined; and this being subtracted from the whole loss from both surfaces under the circumstances of inhalation, gave the amount that evaporated from the lower surface only. At the temperature of 70° F., this proved to be, from the average of several experiments, about at the rate of 24 grains per minute during the first half minute; and allowing, with Dr. Snow, that 20 grains of chloroform correspond to 15·3 cubic inches of the vapour, and that 400 cubic inches of air are inhaled in a minute, we get 4·5 per cent as the proportion of the chloroform to the inspired air, on the hypothesis that all that evaporates from the lower surface enters the lungs; 5 per cent being what Dr. Snow was led by his experiments to regard as the proportion at which the respiration was quite sure to fail before the circulation, and that at which he aimed with his inhaler (op. cit. p. 84). On the other hand, Dr. Snow assumed that, when the cloth is used at a temperature of 70° F., 9·5 per cent of chloroform is really inhaled (op. cit. p. 34); whereas, in truth, of the 4·5 per cent a large amount is dissipated into the surrounding air.

require most careful management, as is admitted by Dr. Snow with regard to his own inhaler.* On the other hand, there can be no mistake about the manner of using the cloth, which is also always at hand under all circumstances.

The theory of syncope from too great strength of the anæsthetic vapour when the cloth is employed being erroneous, the greater number of the deaths still remain unaccounted for; and, if we except a very few instances for which we seem to have nothing to fall back upon but an idiosyncrasy so rare that it may practically be left out of consideration altogether, their explanation will, I believe, be found in an overdose of this potent narcotic from too long-continued administration.

This is what might be expected from a general view of the statistics. Were we to ask ourselves in what sort of operations we should have anticipated most frequent deaths during the employment of chloroform, we should say in those which are likely to inspire great dread on account of their magnitude and severity, and to cause great shock and great hæmorrhage. More especially should these preponderate among fatal cases in general hospitals, where serious operations constitute the majority of those performed. The reverse of this, however, is what we actually find. Of the whole number of cases recorded by Dr. Snow in 1858, as due to the use of chloroform throughout the world during ten years, nine only occurred in any considerable surgical procedure at a general hospital; remarkably few, considering the enormous number of important operations that must have been performed during so long a period, and the variety in the qualifications of those who administered the chloroform. On the other hand, fourteen took place at similar institutions in connexion with the most trivial matters, such as the removal of a toe-nail, the amputation of a finger, the passing of a catheter, or the cauterising of a wart. The only rational explanation of this seems to be, that when some great operation is to be performed, like the amputation of a thigh or the removal of a stone from the bladder, plenty of well-qualified assistants are present, and each of them, including the giver of the chloroform, is duly impressed with the importance of his office, and bestows the requisite pains upon it. But when some trifle is to be done, the whole affair is apt to be regarded too lightly, and the administration of the anæsthetic is perhaps confided to some unsuitable person, who also allows his attention to be distracted by other matters. This conclusion is entirely in accordance with my own experience, which, while it has convinced me more and more of the safety of chloroform if properly given, has impressed me deeply with the necessity for more vigilant care in its employment than is sometimes apt to be bestowed.

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* Op. cit. pp. 181, 188.

But an overdose of chloroform may be caused by attention misapplied, as well as by want of attention. The requisites for safety in using it will be best introduced by a short account of what ordinarily occurs in the mode of administration with which I am most familiar. A common towel being arranged so as to form a square cloth of six folds, enough chloroform is poured upon it to moisten a surface in the middle about as large as the palm of the hand, the precise quantity used being a matter of no consequence whatever. The patient having been directed to loosen any tight band round the neck, and to shut his eyes to protect them from the irritating vapour, the cloth is held as near the face as can be comfortably borne, more chloroform being added occasionally as may be necessary. After a time, varying considerably in different individuals, but generally longest in adults who have been accustomed to the free use of narcotics, and shortest in young children,* signs of excitement begin to manifest themselves in various ejaculations and muscular efforts, which soon give place to a state of complete repose. The struggles of the patient are sometimes so violent as to require considerable force to restrain them; and, for this reason, at least one efficient assistant should always be in attendance. On the other hand, I have seen chloroform induce nothing but a tranquil slumber; and it is important to bear in mind that the stage of excitement cannot be reckoned on as invariably declaring itself at all.

The most convenient test of the patient being prepared for undergoing the operation is presented by the eye; not in the size of the pupil, which is inconstant in its indications, but in what is commonly spoken of as insensibility of the conjunctiva; though in truth it has no relation to sensation, which is abolished considerably earlier; but when unconscious winking no longer occurs on the eye-ball being touched with the tip of the finger, we have a good criterion of the suspension of reflex action in the body generally. At this period the pulse is in about a normal condition, and the respiration is usually either natural or very slightly stertorous, though persons with a strong tendency to snore may do so almost from the commencement of inhalation. But if the administration of the chloroform be further persisted in, strongly stertorous breathing will soon be induced, and will become aggravated till it passes into complete obstruction to the entrance of air into the chest, though the respiratory movements of the thoracic walls still continue. Occasionally, however, the premonitory stertor is deficient, and the breathing becomes more or less suddenly obstructed. This is a point of great importance; for without close attention it may escape notice, when the patient will be placed in imminent peril. For though the respiration may be resumed spontaneously, this cannot be relied on, and it would seem that when chloroform is given in an overdose, the cardiac ganglia are apt to become enfeebled; and on this account asphyxia produces more rapidly fatal effects than under ordinary circumstances. But if the obstructed state of the breathing is noticed as soon as it occurs, and the cloth is immediately removed from the face, and the tip of the tongue seized with a pair of artery forceps* and drawn firmly forwards, the respiration at once proceeds with perfect freedom, the incipient lividity of the face is dispelled, and all is well.

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* I once met with an instance in which chloroform seemed incapable of affecting a patient. It occurred in the private practice of Mr. Syme, who was about to perform an operation, for which we proceeded to administer the anæsthetic; but after we had used the cloth till we were tired without any apparent effect, Mr. Syme went on with the operation while the patient was conscious. Such a case is, no doubt, excessively rare; but it is interesting as giving some colour to the hypothesis, that idiosyncrasy in the opposite direction has existed in some very few fatal cases, which seem to admit of no other explanation, as alluded to in the text.

I am anxious to direct particular attention to the drawing out of the tongue, because I am satisfied that several lives have been sacrificed for want of it. In order that it may be effectual, firm traction is essential. I have, more than once, seen a person holding the end of the organ considerably beyond the lips without any good effect, and, placing my hand on his, have given an additional pull, that has reëstablished the respiration.

A simple experiment, which any one may perform upon himself, is illustrative of this point. Stertorous breathing, such as occurs under chloroform, may be produced at will, and may be carried on even while the tongue is protruded to the extreme degree. But if the tongue is laid hold of with a handkerchief and pulled so as to cause decided uneasiness, stertorous breathing of any kind becomes impossible. That further traction, when extension already exists to the utmost, should produce such an effect is an apparent anomaly, which it seemed important to explain. On investigating the subject, I noticed in the first place that stertorous breathing is of two essentially different kinds; of which one, that may be called *palatine*, consists in vibrations of the velum, and has either a buccal or nasal character, according as the air passes through the mouth or the nose; while the other, which is the profound stertor essentially concerned with chloroform, depends on a cause seated further down the throat, and, for reasons to be given immediately, may be termed *laryngeal.* By digital examination of my own throat, I found that the latter variety, and the complete obstruction into which it passes, could still be produced when the tongue was separated by a considerable interval from the back of the pharynx, while a free passage for the air existed onwards to the lips; which showed that the general belief, that the obstruction depends on a "falling back of the tongue," is erroneous. Also the epiglottis, instead of being folded back during the obstruction, as some have supposed, had its anterior edge directed forwards, and though it was thrown into vibrations when the stertor was strongest, it was evident that the cause of the sound was more deeply placed. I also found that, although firm traction upon the tongue abolished the obstruction and the stertor, it did not appear to produce the slightest change in the position of the base of the tongue; nor did it move the os hyoides upon the thyroid cartilage, as examined from without. Hence I was led to conclude that the beneficial effect of this procedure could not be explained mechanically, but must be developed in a reflex manner through the medium of the nervous system. The fact that, when sensation is perfect, some degree of pain is caused in the process, implying an irritation of the nerves, was in favour of this view; while the general abolition of reflex action by chloroform did not seem strongly opposed to it, considering that the reflex respiratory movements, including those of the glottis, go on in a person under the influence of chloroform.

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* The artery forceps are the most convenient means of drawing the tongue forwards. The puncture which they inflict is of no consequence; the patient, if he notices it at all, supposes that he has bitten his tongue when under the chloroform.

For further elucidation of the matter, I had recourse to the laryngoscope; and, after a little patience, found no difficulty in inspecting my own vocal apparatus without employing any depresser of the tongue; using simply the small oblique long-handled speculum and a common mirror in bright sunlight. I then ascertained that the true laryngeal stertor results from the vibration of the portions of mucous membrane surmounting the apices of the arytænoid cartilages, *i. e.* the posterior parts of the arytæno-epiglottidean folds (thick and pulpy in the dead body, but much more so when their vessels are full of blood), which are carried forwards to touch the base of the epiglottis during the stertorous breathing, and are placed in still closer apposition with it when the obstruction becomes complete. Having one hand at liberty, I was able to observe the effect of drawing forward the tongue under these circumstances, and saw that firm traction induced the obstructing portions of mucous membrane in contact with the epiglottis to retire from it for about an eighth of an inch, so as to allow free passage for the air, while the epiglottis itself was not moved forwards in the slightest degree.*

Whether pulling the tongue operates by inducing or relaxing muscular contraction in the larynx, may be matter for discussion; but the main conclusion, that it does not act merely mechanically, but through the nervous system, appears satisfactorily established. I have not hesitated to give the evidence on which it rests in full, as it appears to me to be of the highest practical moment. For it shows at once how grievous a mistake is committed by those who content themselves with gently drawing the apex of the tongue a little beyond the teeth, or pushing forward its base with the finger, or perhaps ascertaining that the epiglottis is not folded back. Such proceedings are instances of attention misapplied, and waste the golden opportunity for rescuing the patient from death. The proper treatment, like many other good things in medical practice, owes its origin to a false theory; but though the erroneous notion of obstruction by the tongue did good service in the first instance by suggesting the original method, it now tends to encourage supposed improvements upon it, which rob it entirely of its efficacy.

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* While the true laryngeal stertor was thus produced and thus removed, a sort of spurious snoring might be made by approximation of the vocal cords; but this spurious stertor was, like the voice, quite unaffected by drawing out the tongue. These observations were made on the 21st September of the present year, 1861. I find that there are four ways in which the passage through the larynx may be closed. First, the folding back of the epiglottis over the opening into the pharynx, as is generally believed to take place in swallowing, and may be demonstrated by arresting an act of deglutition in its progress, and insinuating the finger between the tongue and the roof of the mouth to the epiglottis, which is then felt to be turned backwards, and to return to its usual position as the act of deglutition is finished. Second, an approximation of the *sides* of the superior orifice of the larynx, in which the epiglottis is directed forwards, but folded longitudinally, so that its edges are in contact with one another while the arytæno-epiglottidean folds are also in lateral apposition. This occurs in retching, and doubtless also in vomiting, when a folding back of the epiglottis, instead of protecting the larynx, would tend to direct into it the material passing from below upwards. Thirdly, an *antero-posterior* coaptation of the structures of the laryngeal aperture at a somewhat deeper level, without any change in the position or form of the epiglottis, towards which the folds of mucous membrane above the apices of the arytænoid cartilages are carried forwards, till they are in contact with its base. This is seen in coughing, and also in laryngeal stertor; and it is probable that during sleep, when the respiration is so apt to become stertorous, there is but a very narrow chink between the epiglottis and these folds of mucous membrane, which would thus serve to protect the deeper parts of the air-passages from the introduction of foreign matters in the state of unconsciousness. Fourthly, the closure of the *rima glottidis* in the production of voice. The white *chordæ vocales* form a beautiful contrast with the highly vascular structures in their vicinity.

If the above description is correct; if it is true that when the administration of chloroform with the cloth is carried too far, the first serious symptom is an obstructed state of the respiration, which without watchful care may occur unnoticed, and, if allowed to continue, will endanger the life of the patient, but, if promptly treated, will harmlessly disappear,—it follows that the attention of the administrator ought to be concentrated on the breathing, instead of being, as it too often is, diverted by the pulse, the pupil, or other matters still less relevant.

As an example of the risk that is run by want of close attention to the respiration, I may mention the following case. A Surgeon of considerable experience was giving chloroform to a patient on whom an operation was being performed, of which I was a mere spectator; but I noticed that stertorous breathing came on, and gradually passed into complete obstruction, at a time when the administrator was gazing with interest upon the proceedings of the operator. Seeing that the patient was in danger, I suggested to the giver of the chloroform the propriety of pulling forward the tongue. He replied that this was uncalled for, and pointed to the heavings of the chest as evidence that breathing was proceeding freely. Knowing from what had gone before that those efforts were doing nothing for the respiratory function, and feeling that there was no time for discussion, I stepped out of my province so far as to seize the tongue myself and draw it forward, when a long and loudly stertorous inspiration demonstrated the necessity for the interference. Had the delusive movements of the chest been trusted, it is probable that they might have continued till the heart had become so enfeebled by the asphyxial state as to cause no perceptible pulse at the wrist; and had death occurred under these circumstances, the case would have been set down as one in which the circulation failed before the respiration. The administrator would thus have been absolved from all blame; and the fatal event would have been attributed to idiosyncrasy, or to any heart-disease which might have been discovered on *post-mortem* inspection.

The very prevalent opinion that the pulse is the most important symptom in the administration of chloroform is certainly a most serious mistake. As a general rule, the safety of the patient will be most promoted by disregarding it altogether, so that the attention may be devoted exclusively to the breathing. The chance of the existence of heart-disease may seem to make this practice dangerous; but having followed it myself with increasing confidence for the last eight years, and knowing that it has been pursued all along by Mr. Syme, who has also acted on the maxim that every case for operation is a case for chloroform, and must, therefore, have given it to very many patients in whom cardiac disorder existed unknown to him, besides some in whom its presence had been ascertained, I feel no hesitation in recommending it. Even when serious disease of the heart is known to exist, it must be remembered that there is much less risk of syncope than of obstruction to the respiration; and while the latter will demand and repay immediate attention, the former, should it by any chance occur, being in all probability independent of any excess of chloroform, would not imperatively demand its discontinuance; nor would it be much influenced by treatment, supposing the patient to be already in the horizontal posture, which is generally considered safest in all cases when chloroform is given.*

From these considerations it appears that preliminary examination of the chest, often considered indispensable, is quite unnecessary, and more likely to induce the dreaded syncope, by alarming the patient, than to avert it.

The obstructed state of the breathing, if allowed to continue long, would lead to a far more serious affection,—paralysis of the nervous centre concerned in the respiratory movements. Pulling out the tongue would then of course have no good effect of itself, but it should be done to clear the way for artificial respiration, which is the means to be essentially trusted to under such circumstances; and if the air still fail to enter freely into the chest, an opening ought to be made without delay through the crico-thyroid membrane. Cold water should also be occasionally dashed upon the face and chest; and if a galvanic battery happen to be in readiness, one of its poles may be applied over the spinous processes of the upper cervical vertebræ, and the other to the præeordial region, with the object of rousing the respiratory and cardiac ganglia. This, however, is a means not very likely to prove beneficial, and, if used in too intense a form, it may do harm instead of good.

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* From the views expressed in the text regarding the relation of syncope to the administration of chloroform, it might be inferred that no great danger would be incurred by giving it in the sitting posture when circumstances particularly require it; and accordingly Dr. Snow informs us that he has done this on several occasions without any bad result. But considering the possibility of an overdose, and the feebleness of the heart which that seems to entail, it is no doubt wisest, as a general rule, to have the patient reclining. Dentists, it is true, give chloroform in the sitting posture; but so far as I have seen, they do not carry the administration beyond a slight degree, sufficient to deaden sensation without affecting reflex action, dexterously managing to open the mouth and operate upon it while the muscles of the jaws are rigid.

Preparatory to taking chloroform the patient should be directed to omit the last meal which would naturally precede it, as any food in the stomach is almost sure to give rise to troublesome vomiting during the inhalation. The only after-treatment necessary is to allow the effects of the chloroform to pass off in a quiet sleep; and the only bad consequence likely to arise is a tendency to sickness, which sometimes causes annoyance during the first twenty-four hours or so.*

Chloroform is universally applicable in the various departments of surgery, except in some few cases in which the assistance of the patient is required, and in operations involving copious hæmorrhage into the mouth. Blood may trickle in small amount into the pharynx without risk of choking, deglutition being carried on unconsciously during anæsthesia; and even in some instances when the bleeding is more serious, as in removing portions of the jaws, pain may be avoided to a great extent by giving the chloroform during the more superficial parts of the operation, and allowing the patient to recover partially before undertaking its deeper stages.

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* It has been supposed by some that the use of chloroform increases the risk of pyæmia after capital operations; but experience has now abundantly proved the groundlessness of this apprehension. To take a single instance, the veins of the pelvic viscera being perhaps more liable than any others to originate phlebitis after surgical interference, lithotomy would be much more fatal now than formerly, were there any foundation in fact for the notion. The reverse, however, appears to be really the case. Thus, Mr. Cadge, one of the Surgeons of the Norfolk and Norwich Hospital, an institution long celebrated for the successful treatment of stone, in a district abounding in calculous disease, informs me that the mortality after lithotomy has been still further reduced there since the introduction of chloroform. (Recent statistics of lithotomy at the Norfolk and Norwich Hospital will be found in the *Lancet* for August 18th and September 1st, 1860.)

The main conclusions arrived at in this article may be expressed in a few words. It appears that chloroform, though resembling many other valuable means of treatment, in being deadly when mismanaged, is free from danger if properly used; the following being the rules for its safe administration. A drachm or two of the liquid having been sprinkled upon the middle of a folded towel, hold it near the face, taking care that free space is afforded for the access of air beneath its edges, till the eyelids cease to move when the conjunctiva is touched with the finger. Meanwhile watch the breathing carefully; and if at any time it should become obstructed or strongly stertorous, draw the tip of the tongue firmly forwards till the tendency to obstruction has disappeared.

These simple instructions may be acted on without difficulty by any intelligent medical man. The notion that extensive experience is required for the administration of chloroform is quite erroneous, and does harm by weakening the confidence of the profession in this invaluable agent, and limiting the diffusion of its benefits.

JOSEPH LISTER.

PLASTIC SURGERY.

ABOVE three hundred years ago there lived in Bologna a physician of the name of Gasparo Tagliacozzi, who excited far and wide attention and wonderment by his operations and cures. Some regarded him as a sorcerer and necromancer; others as a liar or boaster. No one, however, could comprehend how he accomplished his wonderful cures. Equally little could any one prove aught evil in his actions or behaviour; for he was a man much respected in Bologna; he was Professor of Anatomy and Medicine, beloved of all students, and so honoured by his fellow-citizens that they erected to his memory after his death, in the anatomical theatre at Bologna, a marble statue with this insignia of his art—a nose—in his hand. But he had thus far a connexion with "necromantic" arts. Before his time Surgeons, as occasionally in the present day, had sought to obtain eminence by cutting off arms and legs, by boring the skull, and by burning and cauterising the flesh. He, however, regarded the matter in a different light; for far from taking any thing away from the patient, he endeavoured, and found a pride therein, to replace parts which had been lost to them,—namely the nose, lips, and ears,—and that not by wood, pasteboard, silver or gold, but (as was at least then currently believed) by true veritable flesh. There needs no extravagant phantasy to imagine what notice and envy he thus excited, and how he drew upon himself satires both in prose and verse; the more so because his art was regarded as a mystery, and no one could accurately understand whence he obtained the new nose. So much, however, seemed certain to all, either that he obtained a real human nose taken from another person, or that he cut the organ from some tender flesh, either from chickens or calves, and patched it on to the mutilated persons. Tagliacozzi, however, disdaining to spread about himself or his art a mystery, wrote, in the year 1597, a large work in folio, *De Chirurgia Curtorum per insitionem*, wherein he opened the eyes of people how and whence he made these artificial pieces, namely out of skin. Thus says Dr. Fritze,* who wrote in 1845 a just tribute to the talent and originality of a great man. The lines in *Hudibras* have become trite, meaningless, and vulgar; while Tagliacozzi's experimental confirmation of a great physical truth lives to be only more honoured and believed.

It is no refutation of the claims of Tagliacozzi to say that Surgeons are often disappointed in their expectations; that the descriptions given by the early apostles of plastic surgery were florid or exaggerated. The fundamental truths remain the same; the transplantation and reunion of flaps of integument is a proceeding adopted and recognised by all Surgeons, although they have learnt that the ultimate result is generally of no more favourable character than to warrant the proceeding in cases where the patient experiences a positive evil. We do not quite accompany Dr. Fritze, when he says, in his glowing language, "A perforated and corroded fleshy knob, which brings woe to the possessor who carries it on his shoulders, and horror to every one else, is converted by plastic surgery into a human physiognomy, and gives back to the discarded and avoided person both life and society; the eye, which, deprived of its natural covering, becomes dry and inflamed, and would withdraw itself, but in vain, with convulsive efforts, from the destructive influence of light and air, seeking the repose which avoids it, is covered again with protective eyelids, and regains life and sleep; a mouth, puckered up and grown together like an eyelet-hole; for which no food is suitable save soup and thin broth, and whose expulsive articulation resembles the cry of the wild beast, again gives forth human sounds, reopens, and allows the patient both to eat and speak. Have I yet," he says, "occasion to relate that plastic surgery has the power to heal both urinary and fæcal fistulæ, and thus to remove the greatest physical suffering with which man is afflicted in this world?"† Let us divest the subject of this high colouring and romance; and, while acknowledging its utility, remember that "the artificial nose, even the most complete, can never fully equal the natural; that the patient need never expect it." "Nature ever triumphs over art, and here is the boundary between what is godlike and human."‡

Certain subjects, those indeed most commonly illustrative of plastic surgery, will in this work be treated under other heads.

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* *Die Plastische Chirurgie*, an excellent work, to which the reader may be referred for a history of the art of Plastic Surgery.

† Op. cit. p. 2.

‡ Ibid. p. 3.

Thus, fissured palate, &c. comes under the head of DISEASES OF THE MOUTH; entropium, ectropium, and closure of the lacrymal sac, under that of DISEASES OF THE EYE; imperforate anus, under SURGERY OF CHILDHOOD; recto- and vesico-vaginal fistula, under DISEASES OF THE FEMALE ORGANS OF GENERATION. We propose, therefore, here to deal more with general principles, and to apply them to such subjects as are not included in the above headings.

Now all deformities, whether remediable or irremediable by surgical operation, may be classed under two heads: the congenital, and the non-congenital; and this distinction must be borne in mind in most of the cases we are called upon to treat. A congenital deformity implies an arrest of development, possibly a congenital deficiency of parts, or a relation such as should exist naturally only in fœtal life. In the non-congenital or acquired deformity, parts already formed and normally proportioned have been injured or destroyed. There are but few exceptions to this rule. The treatment of the former is in severe cases more unsatisfactory than that of the latter. For instance, a simple congenital fissure of the lip, constituting hare-lip, may be united in the usual way; but there is mostly some abnormal marking on the integument, which ever afterwards indicates the operation which has been performed. Moreover, the fissure may extend into the hard and soft palates; or the irregularity of development may influence the position of the incisor teeth. The case is obviously more complicated than one of simple division of the upper lip by accident or surgical operation; and the Surgeon should bear this point in mind; for although, as regards the mouth, the statement is obvious enough, there are other situations where want of attention to the law of fœtal relations may be followed by serious consequences. When the bladder is open in front from congenital defect (extroversio vesicæ), the fissure in the organ and in the abdominal parietes is not the only defect. Bladder, prostate gland, and peritonæum, rectum and pelvic bones, retain very much of those relations which existed at the moment when the bladder failed to close. In other words, from that moment parts grew in size, but ceased to be developed to the normal bearings of the adult. Should the Surgeon in such a case endeavour to establish a recto-vesical fistula (as has been several times attempted), by passing a trochar from the rectum into the bladder in order to divert the stream of urine, he will make the discovery that there is rarely any safe spot which the instrument may traverse: the prostate gland is small; the peritonæum comes down to its very border, as it would in the young infant; the bladder is more of an abdominal than a pelvic viscus. Hence fatal peritonitis ensues before the Surgeon has had time to establish those conditions, which he trusted would enable him to close, by a plastic operation, the abdominal fissure through which the urine escaped.

The powers of repair and of reproduction in man, upon which depend the success of all plastic operations, are very much more limited than in the lower animals. We need not here dwell upon the well-known instances of the re-formation of the lost leg to the salamander or the lost claw to the crab, but may remark that in man the hair, the nails, the epidermis, and epithelium seem alone to possess the power of complete regeneration. It is doubtful if, under any circumstances, tissues of even the lowest organisation and of the lowest chemical characters, such as the cellular and tendinous, become replaced completely, when once removed, with all the characters they had before. The tendons preserved in the museum of the College of Surgeons of England (Nos. 358, 359, 360), which have been often brought forward as instances of complete regeneration of lowly organised tissues, do but illustrate the contracting power of recently effused lymph, and the gradual approximation of the ends of the cut tendon so as to form a linear cicatrix. In 1858 I had the opportunity of examining two Achilles tendons, which had been subcutaneously divided at periods of two and three months previous to the death of the patient;* and it was there seen, after making a longitudinal incision, that the divided ends of the normal tendo Achillis, two inches apart, were united by a light gray semitransparent structure, quite different from natural tendon, and readily distinguishable to its very boundary. Had no mechanical extension been employed, this new material would have contracted, like any other cicatrix, and have gradually approximated the separated ends of the true tendon.

Whatever the microscope may reveal, the fact is undoubted, that when the entire thickness of the skin has been destroyed, the tissue which replaces it never exhibits the same characters or perfection as before. A superficial layer may be disorganised, when repair goes on by a superficial layer of granulations, and no trace of the injury after a time is perceptible. But the case is otherwise when the whole thickness of the skin has perished. The smooth white cicatrix retains its own characteristics, and contracts for months and even years, gradually drawing closer around its decreasing circumference the surrounding integument, and acting, though slowly and gently, yet with a force that no tissue, however hard, can resist, distorting the features, and exercising an influence on the shape of the growing bone and on the direction of the teeth. Let no Surgeon, who hopes to remove a deformity, ever trust to the persistence of a large cicatrix ; let him likewise remember that every incision which he makes involves the formation of this newly effused and readily contracting uniting medium ; and he may perhaps be more wary than has hitherto been the case in attempting the removal of contractions by operation.

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* *Medical Times and Gazette*, January 9th, 1858.

In plastic surgery the operator avails himself of the true skin, with the subcutaneous areolar and fatty tissues ; sometimes likewise of the mucous membrane. Fritze justly remarks that the transplantation and union of bone-fragments, as well as of teeth and hair, is very problematical. Walther[*] speaks of the reunion of a piece of trephined bone ; Weisemann,[†] of the adhesion of teeth ; Dieffenbach, of the transplantation of hair. Hunter's experiments upon this subject are also well known. They are all, however, of more physiological interest than practical utility.

"We have to deal in plastic operations with the integument only," says Fritze ;[‡] "and can as little make a new nose out of a fowl's breast, as cut out and form a similar organ out of the thick muscular flesh of the arm." The flap for transplantation should be taken from the individual on whom the deformity is to be rectified. Thus, if a new nose is to be formed, the skin should be taken either from the immediate proximity of the damaged organ, as the forehead or cheeks, or else from a part which can be readily approximated, such as the forearm. Bünger relates a case of partial success in the formation of a new nose on a lady by a piece of integument completely cut away from the thigh ;[§] and Hoffacher, who was officially appointed to attend at the duels frequent among the students at Heidelberg, mentions some remarkable instances, which are attested by Chelius and Velpeau, of the reunion of parts completely sliced off by sword-cuts ; *e. g.* portions of the nose, lips, or chin. But no such license can be allowed in plastic surgery ; the flap must retain its connexion to the adjacent living structure by a pedicle, which is to be severed only after complete union and cicatrisation of the raw surfaces. The idea of taking the flap of integument from another individual, and binding the two persons together until union shall have taken place, is preposterous to English notions; although stated to have been entertained and practised in eastern countries, where plastic surgery has been known from time immemorial.

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[*] Th. v. Walther, *Wiedereinheilung der bei der Trepanation ausgebohren Knockenscheibe.*

[†] J. H. Weisemann, *De Coalitu partium a reliquo corpore prorsus disjunctarum*, Leipsiæ, 1824.

[‡] Op. cit. p. 5.

[§] Bünger, *Gelungener Fall einer Nasenbildung aus einem völlig getrennter Hautstücke aus dem Beine.* See Grüfe und Walther's *Journal*, Bd. iv. p. 569.

The flap of integument, separated from its connexions by the knife, and hanging only by the pedicle, becomes at first blanched and white from loss of blood, and also somewhat shrivelled or shrunken. After the hæmorrhage has ceased, it may acquire a marbled aspect from irregular accumulation and stasis of the blood; and the temperature perceptibly falls. Soon, however, the redness and warmth return to it in its new situation, and hæmorrhage may commence from its under surface afresh. Thus it continues for some hours, the flap sometimes paler, sometimes redder, as the vitality loses or acquires power, until ultimately, when circumstances are favourable, the latter condition prevails, and even puffiness and swelling may supervene before the parts regain their normal aspect.

Now, inasmuch as the success of all these operations depends upon delicacy of manipulation and extreme accuracy in detail, let me warn the student that there is no more frequent source of failure than the presence and persistence of a clot of blood, whether primarily or secondarily effused, under the flap. Hæmorrhage is an evil in all stages of plastic surgery; and therefore the Surgeon is accustomed to wait before attaching the bleeding flap to its new connexion, well knowing that no time is more favourable for the effusion of plastic material than when the parts are dry and even somewhat glazed. He likewise keeps the patient moderately cool, maintaining the natural heat of the body on one hand, and avoiding all causes likely to produce excess of action on the other; for should bleeding recur, the wound may need to be reopened.

Among the accidents which befal the transplanted flap is one to which particular attention has been directed by Mr. Skey.* "It will occasionally happen," he observes, "after some days from that of the operation, that the new structure begins to lessen in size, and continues to diminish, till it becomes almost absorbed. My experience in nose-making, though not small, is not sufficiently great to enable me to explain this fact; whether owing to the small size of the stalk, or to the want of general activity in the circulation,—but such is the case." That the shrinking of the flap is rather due to the latter than to the former cause, was illustrated by a case under my own care in St. Bartholomew's Hospital. In 1859, a boy was admitted suffering from disease of the knee and symptoms of early tubercular deposit in the lungs. I amputated the limb according to the method proposed by Mr. Teale; that is to say, by making a long rectangular anterior flap of integument, and bringing it under the stump to unite with a short flap at the posterior aspect of the limb. The case terminated favourably; but with the cicatrisation of the wound the anterior flap shrunk so considerably, that it but little exceeded in size the smaller posterior one to which it had been united. The limb had the aspect of having undergone the usual flap-operation.

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* Skey, *Operative Surgery*, 2d edit. p. 524.

Gangrene usually appears about the third or fourth day. If the flap retains its vitality beyond this time, union generally proceeds without interruption. The mortified parts assume a grayish colour, look soft and pulpy, and the cuticle loosens; or the flap may become dry, shrivelled, and withered. But even under these circumstances let not the Surgeon remove it; he should rather cover it with cotton-wool or a soft bread-and-water poultice, or with water-dressing, *i. e.* wetted lint covered with oiled silk or gutta-percha; for he cannot tell either how far or how deep the loss of vitality may extend. The edges of the wound alone may die; or the superficial parts alone may be thrown off. If even the smallest portion of skin remain in its new situation, it may afford the patient partial relief, or serve as a groundwork materially to facilitate any future proceedings. I will add only this caution: if the wound happen to be going on unsatisfactorily, let the Surgeon cover it up, and abstain from frequent examinations. He will see in a few days, without repeated inspection, how much nature has been enabled to effect.

It is unnecessary to speak of the many inconveniences attending an attack of erysipelas after the operation, inasmuch as this disease has been described elsewhere. Every proper precaution should be taken to prevent such an accident: the room should be clean and airy; the dressings light, and easily though not often changed. The general condition of the patient should be such as to render unnecessary purgative or other disturbing medicines; he should take such nourishment as his circumstances best admit. By preserving the standard of health as near as possible to its normal state, we put the patient in the best condition to resist injurious morbid influences.

The object of the Surgeon in all cases is to obtain union by *first intention.* The same observation will apply to this as was made above. The surfaces which we wish to unite should be held accurately together, with the smallest amount of irritation, until a layer of plastic lymph is exuded; an event which takes place at any time between twenty-four hours and three days.

The flap of integument having been cut to the proper size, cleaned of extravasated blood, and fashioned to its new situation, we proceed to inquire into the best method of holding it there until nature has accomplished her part. Although the employment of metallic sutures is not a modern discovery, yet too much credit cannot be given to Dr. Marion Sims for his energetic advocacy of their use, and for the earnestness with which he has worked out their practical application. Indeed they may be said to have fallen into disuse until the publication of his anniversary discourse before the New York Academy of Medicine.* Few Surgeons will fail to endorse his opinion, that "in plastic surgery it is the great desideratum." "In May 1850," he observes,† "a gentleman had the misfortune to lose a good part of the left ala nasi. In the operation eight interrupted silver sutures were used. They were removed on the seventh day: union was perfect, and he soon went home, with some slight tumefaction of the parts, which gradually subsided. In the course of a fortnight he returned, saying that in wiping the perspiration from his face, he discovered some pricking substance at the seat of the operation, which he supposed to be a bit of wire. He was right; the wire was there, but easier felt than seen. It was removed, and found to be half an inch long; it had remained there four weeks, producing no sense of soreness, and no inflammation or suppuration, as a silk ligature would have done; thus establishing the great and important principle that silver was as innocuous as lead, and, like it, might become sacculated, producing no irritant or poisonous effect whatever." In 1852, a little boy, some eight years old, received a blow on the upper lip, near the left commissure, cutting it through for three-quarters of an inch. Three interrupted silver sutures were applied, and no other dressing. Dr. Sims saw no more of him till the ninth day: "union was perfect, the wires remaining precisely as I had placed them. Their removal was like that of a delicate ear-ring from the ear long used to wear it." In 1853 the same Surgeon performed a serious operation on a gentleman suffering from cancer of the lip. The patient went home (some 80 or 100 miles) immediately after the operation, and returned to Dr. Sims in a week. The cut surfaces of a V-shaped incision had been united by four interrupted silver sutures: union was perfect throughout, the wires having produced no inflammatory effect whatever.

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* *Silver Sutures in Surgery;* the anniversary discourse before the New York Academy of Medicine, delivered on the 18th November 1857, by J. Marion Sims, M.D., Surgeon to the Woman's Hospital: New York, 1858.

† Op. cit. p. 32.

I do not multiply instances either from my own experience or that of other Surgeons, because it is only just to Dr. Sims to quote his own cases of early success; and I believe, however slow the Profession may have been in adopting this suture, the universal feeling would now be in its favour in all cases of plastic operations. The parts may be covered with a rag moistened with water, or even be left exposed to the air, according to the feelings of the patient. The method of introducing the wire sutures has been already described;* the time of their removal must be left to the discretion of the Surgeon: probably the mean time would be between a week and a fortnight.

The shotted suture is no modern invention. Two or more pieces of silver wire are passed across any deep wound, at equal distances from each other, by means of a slightly curved needle. The two extremities of each wire are passed through a small hole drilled in a bar of plated metal, the length of which should exceed that of the wound. The wires are first fixed beyond the bar, on one side of the wound, by means of perforated shot, about two of which may be strung on each wire, and compressed by means of a pair of pliers. The opposite end of each wire being now strung with perforated shot, the wound is drawn together, the shot pushed up to the bar and compressed, as on the other side. The superfluous wire may be cut off with the cutting-pliers.

Rhinoplastic Operation.

Tagliacozzi's operation for making a new nose was as follows. After proper preliminary measures regarding the general health, the patient was made to sit during the operation, supported by an assistant; the operator stood in front. The piece of skin to be transplanted was taken from the left upper arm, over the biceps muscle. The Surgeon raised the skin by means of a pair of broad-bladed forceps, of somewhat peculiar shape;† and when he had satisfied himself that he seized a piece of sufficient size, he closed the blades, and fixed the handles by means of a simple clasp. He then passed a double-edged knife through a horizontal fissure in the broad blades of the forceps and through the skin, thus separating the latter from the subjacent muscular tissue, but leaving it attached by a pedicle, both towards the shoulder and the forearm. A piece of lint soaked in oil or simple cerate was inserted under the flap, to prevent union from taking place; and it was retained in its position under the skin till the fourth day, when the dressing was changed, and renewed daily until suppuration was established. If the flap had then begun to thicken and the edges to become incrusted, it was cut free at its upper end, presenting a line with the convexity directed upwards. It was then most carefully dressed and attended to, until the under surface had become cicatrised as far as possible. Remaining attached by one extremity to the arm, it underwent a process of thickening, contraction, and wrinkling, accompanied with the growth of hair, which Tagliacozzi fancifully compared to different stages of growth. About the fourteenth day after the second operation, it was considered to be in a state of maturity. The patient was purged, cleanly shaved, and supplied with a leather jacket, which was to serve as a support to the arm when raised to the face. The jacket, or jerkin, consisted of a cap and of a breast-piece. The edges of the flap and of the nasal aperture were then pared, and the two parts were prepared for union by sutures.

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* See MINOR SURGERY, p. 14. All the common forms of suture will be found described in that essay.

† See Fritze, op. cit. plate ii. fig. 1.

The arm rested in a semiflexed position, on a cushion, while the ligatures were being inserted and tied: it was retained in that position by a leathern apparatus, the different parts of which were attached to the cap and breast-piece by bands and straps. The patient was kept in bed, under a strictly antiphlogistic treatment. The ligatures were taken out on the third to the fifth day; but the flap was left resting upon some lint or rag covered with albuminous material until the twentieth day. The Surgeon then loosened part of the arm-straps, severed the remaining attachment of the flap to the arm, and covered the wound with proper dressings. If the septum nasi was deficient, a piece was taken from the upper lip by a subsequent operation.

According to the spirit of the age in which he lived, Tagliacozzi invested the stages of the operation, the instruments and apparatus, with unnecessary names; he is likewise tediously minute in his description, of which the above is a very brief outline. But he has a fair claim to the renown which has attached itself to his name, for the boldness with which he instituted his proceedings, and the care with which he followed his cases to their completion. Many have attempted to adapt the different stages of Tagliacozzi's operations to the ideas of modern surgery; but I think we may affirm, that the practice of taking the integument from the arm is exploded, and that in all cases the Surgeon now prefers to avail himself of the parts adjacent to the nose, namely the forehead or cheeks.

Among those who have performed the rhinoplastic operation with skill and success, Mr. Skey holds a prominent position. The disease to which the destruction of the nose may be usually assigned is lupus, which, having involved the cartilaginous structure, leaves the bone untouched. Occasionally the ossa nasi are also destroyed; and then, Mr. Skey believes, we may infer that such a patient has employed mercury largely for supposed syphilitic or venereal disease. "If the bones be entire, the operation is more likely to be a successful one. If the bones be destroyed, the condition of the patient precludes the resort to the best operation, and the result is far less promising, from the loss of the arch on which the superstructure is laid."*

Before proceeding to the operation, the Surgeon should take the dimensions of the required organ in card, paper, or gutta-percha. The new material is taken from the forehead, and connected to the root of the nasal bones by a narrow stalk-like process. When the flap of the integument is insulated, this stalk is twisted, so as to enable the part to be brought down vertically. The integument, continues Mr. Skey, should be removed longitudinally from either half of the forehead, running outwards towards the temple, in order to render the twist as inconsiderable as possible; and when the admeasurement is complete, at *least a quarter of an inch on all sides* should be allowed for the contraction of the skin: in fact, the flap can hardly be made too large, and it is surprising how slight a stalk is requisite to carry on the circulation. When the card has been fitted over the meatus, it should be laid out on the forehead, and all its dimensions extended and marked in ink. The part that is to represent the columna should be very broad, probably more than half an inch. Mr. Skey puts the patient in the horizontal posture. He commences by paring the margin around the nose pretty freely, in order that the exposed edge should be sufficiently large to receive the corresponding margin of the new integument; and the skin on the lower surface of the ossa nasi should be entirely removed by the knife. When this stage of the operation is completed, a deep incision should be made along the inked line on the forehead, slowly and cautiously, for one slip of the knife may render the whole operation nugatory. The lower edge of the incision will pass across the fibres of the corrugator supercilii, which muscle may be detached with the integument. If the knife be so held as to slope a little inwards, it will give an acute angle to the cutaneous surface of the flap, by means of which the two surfaces may be adjusted with more precision as regards the continuity of surface. When the flap is detached in every part except at the stalk, which of course is most carefully preserved from injury, the wound should be left to bleed, and no attempt made to adapt the surface until the bleeding has *entirely ceased.* Before leaving the flap, it is better to scoop out a little of the substance along the central line of the columna, in order that, by being hereafter compressed, it may fold together and resemble as much as possible the original structure. When brought down, the columna should be first united to the raw surface made for its reception. There is some difficulty in applying the suture in this situation, from the density of the structure forming the base of the nose. For this purpose, a much-curved needle must be employed, which should embrace a considerable piece of the cartilage. It may be advisable to employ two sutures instead of one. The sides are then first united by about three good-sized sutures, and the intervals adjusted as exactly as possible by the aid of six, eight, or ten of the finest sutures that can be employed (fine silver-wire sutures are now employed). The nostrils should be elevated by means of pieces of cork and cotton-wool, and generally pressure of moderate force made laterally by the same material and a bandage, care being taken to prevent all pressure on the dorsum. The wound on the forehead should be drawn together with good plaster. At the expiration of about a month, or as soon as the new parts have firmly united, the lump, always caused by the twisting of the stalk, should be pared away, and the knife applied to remedy any positive deformity in the line of the cicatrix.

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* Skey, *Operative Surgery*, 2d edit. p. 521.

This operation of bringing the flap from the forehead is designated the Indian operation, and was first introduced into Europe by Mr. Carpue in 1814, who improved upon the original operation by adding a septum nasi, and by the employment of sutures. He was soon followed in Germany by Gräfe, by Dieffenbach, and by others; and the results have been successful. At the end of three or four days the flap will be found tumid, warm, and sensitive, but pale; and at this time, Mr. Erichsen recommends that the plug in the nose be changed, lest it be rendered offensive by the discharges. He rightly, however, adds, "that its withdrawal, and the substitution of another, must be done with the greatest gentleness, the Surgeon bearing in mind that any undue pressure or traction may destroy adhesions, and prove fatal to the vitality of the flap."

Some Surgeons make the columna nasi in the operation from the upper lip, as in the method proposed and adopted by Tagliacozzi. In cases where there has been great destruction of the bones, or where, as after syphilitic disease, the nose becomes completely depressed, Larrey and Dieffenbach have revived the operation of Celsus, and have taken the integument from the cheeks. "A young girl had lost the proper bones of the nose, the vomer, the greater part of the nasal apophysis, the malar bones, and the lamellæ of the ethmoid. The integuments were folded into the nasal fossæ, and presented the general aspect of a countenance sunken by death. Dieffenbach made along the sides of the depressed nose, in its whole length, two incisions penetrating to the bone. There resulted a band of skin, isolated, and adhering only at the upper and lower ends; it was broader in the latter than the former: a vertical incision along the middle line divided this portion of skin into two. The lateral incisions were continued inferiorly by two semilunar incisions, which separated the alæ nasi from their external connexions. He dissected these two flaps from below upwards, separating them completely from the nasal cavities into which they had been folded. He then separated, for some distance, the thick substance of the cheek. Having completed these steps, he united by six sutures the edges of the median incision, and brought into contact the edges of the lateral incisions by eight sutures. The nose then seemed to regain some of its natural prominence and form, the nostrils being kept distended by pieces of lint soaked in oil. As the last stage of the operation, he approximated the separated and dissected cheeks, under the nose, by passing through their substance a long needle."* We mention this operation, not in terms of commendation, but rather to show what has been attempted and done with some share of success. We must, however, warn the young Surgeon that, in these *opérations de convenance*, the sources of mishap are numerous, and disappointments will occur in spite of the endless variety of modifications adopted by different Surgeons. Mr. Skey gives a good piece of advice when he says, "let it be the patient who urges the operation." The operator will be thus released of some share of responsibility. "In one of Mr. Liston's early cases, the new nose sloughed under an attack of inflammation; in another, hæmorrhage occurred under the flap, on the ninth day, to the extent of more than a pint of blood. Lastly, the operation is not without its dangers: Dieffenbach lost two patients out of six on whom he operated in Paris, their constitutions being probably in an unfavourable state."*

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* Malgaigne, *Méd. Opérat.* 1843, p. 421.

In the construction of a new ala nasi, the Surgeon takes the integument from the cheek. He must trust to his skill, and the circumstances of the case, to guide his incision.

Cheiloplastic Operations. Operations for Defects of the Lips.

Hare-lip. The well-known deformity called hare-lip is a congenital fissure of the upper lip. I never met with a case in which the under lip was similarly affected. The fissure may be single, generally a quarter or a third of an inch from the mesial line—more often, according to Malgaigne, to the left than the right—and presenting at the lower angle a rounded and cicatrised appearance, which must be removed at the time of operation. Or it may be double, in which case there are two fissures, separated by a median flap. The deformity may be complicated with fissure of the bony or of the soft palate; the fissures in the former may be double. There may be fissures of the soft palate without any corresponding cleft in the lip.

The piece of bone behind the median flap in double hare-lip and double fissure of the palate is the homotype of the premaxillary bone in the lower vertebrata, and it generally contains the two front incisor teeth. Its size and the amount of projection vary considerably, but it is always a source of operative complication.

We do not propose to enter into the subject of arrest of development to which this deformity is due, but remind the reader of the statement already made, that in very many cases there are other congenital deficiencies coexistent. Among these rank foremost the teeth, which are often a source of subsequent trouble. I have under my care an infant with fissure of both hard and soft palate, double club-feet, with deficiency of the extensor muscles, and want of muscular power in both hands. It is obvious that in such cases surgical interference should be postponed.

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* Erichsen, *Science and Art of Surgery*, p. 670.

The treatment of hare-lip is of very ancient date. We propose to confine the following remarks to the best mode of rectifying it as at present practised. The operation should be performed as early as possible; certainly before dentition has commenced. The closure of the fissure not only gives to the child the facility of sucking even immediately after the operation, but leads also to greater regularity in the development of the teeth. Delmas operated two hours after birth! Mr. Lawrence has often operated between the third and fourth week. I have frequently done the same. Mr. Fergusson recommends about the sixth week, which Mr. Erichsen regards as the time of election. Mr. Skey doubts the advantage of its being undertaken at a period earlier than three or four months. Richter and Bell recommend a still later period. But if the child is strong and well nourished, a month or six weeks is about the proper time. Chloroform should of course be given, as infants become readily affected, and, as far as experience goes, with the smallest amount of danger.

Operation. The child having been swathed in a piece of sheeting, and the lips being held by an assistant, who grasps them in their whole thickness to prevent hæmorrhage from the coronary arteries, the Surgeon first finds it necessary to separate the mucous membrane and frænum with a scalpel from the alveolar border of the upper jaw, in order that the edges may be the more easily approximated. He then seizes the lower angle of each of the sides with fine sharp-pointed spring forceps, and either with a sharp knife or with knife-bladed scissors pares the edges effectually. Without waiting for the cessation of hæmorrhage, which would blanch the infant, the Surgeon then passes the hare-lip pin deeply through the substance of the lip, commencing from one-third to one-half of an inch from the cut surfaces. A strong silken thread is wound round the pin, bringing the cut edges into contact, in the form of a figure of eight. I then prefer to introduce a fine silver suture at the upper end of the wound to bring the nares into shape, and a second at the red of the lip to preserve the continuity of that important feature. The child is allowed to sleep, or to suckle if it pleases.

I prefer the two sutures to the practice of introducing a second hare-lip pin, because the former hold the parts more immovably in contact. I operated some time ago on a child, in whom I omitted to put the suture near the nares. Soon after the operation catarrhal discharge from the nose came on; the silk round the hare-lip pin became softened and loose before its time, and the fissure partially reopened. Mr. Lloyd is in the habit of preserving a small slip of the flap of the long half of the lip (when such inequality exists), and of attaching it to the under surface of the shorter half, that there may be no notch or fissure when cicatrisation has taken place.

Mr. Skey observes: "In consequence of the greater extensibility of the lower than the upper part, the result of the operation for hare-lip is to leave a permanent deformity, caused by the retraction of the cicatrix, and the formation of an angle below, at the point of union. To obviate this evil, the lines of incision should be curved inwards."*

The hare-lip pin should be shortened at both ends by means of cutting pliers. Some Surgeons have omitted the pins, and substituted the silver sutures; but, although union may be thus obtained, I am of opinion that a part so movable as the upper lip requires the firmer support of the strong metallic pin.

It is customary to remove the hare-lip pin about the fourth day. It should be gently withdrawn, and if the dried figure-of-eight piece of silk remain adherent, it may be left on the lip, where it serves as a plaster. There are some who remove the pin on the third day; others who leave it till the sixth or seventh. In the one case the union may be still too weak to hold; in the other, the pin may have cut its way out by ulceration. If the sutures are of silk, they should be taken away in twenty-four to forty-eight hours; if of silver, they may remain as long as the Surgeon thinks proper. At the time of the removal of the hare-lip pin, the cheeks should be well pressed towards the middle line by an assistant, that no accident may occur to the newly-united parts by the act of crying, which commonly ensues. Then a long piece of adhesive strapping, a quarter of an inch wide and three-quarters of a foot in length, should be passed, across the wound, round the head just over the ears two or three times, by which the parts are protected against all strain. I think the strapping preferable to Mr. Hainsby's spring cheek-compressor, mentioned in Fergusson's *Practical Surgery;* but the instrument accomplishes satisfactorily the same purpose.

In cases of double hare-lip it is safer practice to operate on and to unite the fissures separately. Some Surgeons, however, have recommended that both fissures should be pared simultaneously, and that the hare-lip pins should be pushed through the central flap. Such a proceeding unnecessarily increases the chances of accident. When the bone containing the incisor teeth projects so far forward as to interfere with or to prevent the easy apposition of the pared edges of the lip, it may be cut away by bone-pliers at a separate operation; and this measure is not uncommonly necessary. But in many cases gentle pressure will make it recede in the course of a few weeks; a proceeding strongly advocated by the late Sir A. Cooper, who objected to cutting away the bony projection. A case is related in which an infant of two months old, suffering from hare-lip and projection of the bone, was subjected to pressure for a period of three months; when the bone had been so effectually depressed by means of a kind of spring-truss, which was worn several hours daily, that the soft parts admitted of being brought over it with tolerable facility. Union followed very well.* Desault applied pressure by means of a band tied tightly behind; and it is said that in one case he accomplished his purpose sufficiently in eighteen days. M. Gensoul seizes the piece with strong forceps, partially breaks and forces it into the perpendicular, and this proceeding has proved successful. Mr. Lloyd has adopted the same plan in St. Bartholomew's Hospital, and also with good result; the preservation of the incisor teeth being an object of considerable importance. If the piece is connected to a perfect septum nasi, it is a good plan sometimes to cut a triangular piece (base downwards) out of the latter before applying a band to press back the projection.

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* *Operative Surgery*, p. 531.

Restoration of the lower lip. The restoration of a part of the lower lip, which has been lost by accident or disease, is accomplished by a simpler operation than that for the formation of a new nose. The new structures must be taken from the cheeks, which readily afford a sufficient supply of both skin and mucous membrane. Malgaigne observes, that he had described the proceeding in 1834; and that the late M. Bonnet, of Lyons, had put it into practice. Serres, of Montpellier, has given a full account of it in his interesting work; but the principle dates back as far as Celsus.

Operation. We suppose the case to be one of cancer affecting the lower lip. All the degenerated parts must be taken away either by a V-shaped incision, according to ancient usage, or by two vertical incisions passing down to the base of the jaw-bone, and united there by a transverse incision.

In the first instance, there will be the loss of a triangular piece of the lip and chin; the angles of the mouth must then be prolonged by a transverse incision on each side into the cheek, so that two triangular flaps are obtained. The borders of the V-shaped incision are then united by suture; while, as regards the upper border, all that is not wanted for the formation of the new lip, which is formed out of the substance of the cheek, is united to the part with which it is in contact. The mucous membrane in the mouth should be united to the skin by fine sutures.

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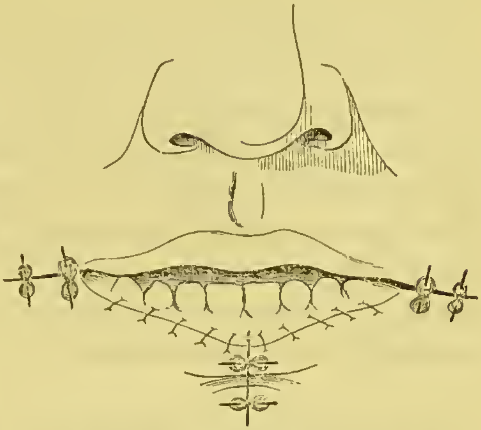
* Cooper's *Dictionary*, p. 594, 1830.



When the loss of substance is quadrilateral, two other incisions, paralled to the two continued from the commissures of the mouth, must be made along the base of the jaw. Two quadrilateral flaps may then be dissected from the bone, brought forward, and united in the median line by sutures, as in the former operation. This last method, says Malgaigne (from whose work the preceding passages have been taken), is but the proceeding of Celsus, badly understood by his translators; a proof that in order to translate a Surgeon, it is not only necessary to know the idiom that he uses, but likewise the science of which he treats.

It follows from this proceeding, that the cheeks alone contribute to form the lip, the free border of which is constituted by the bleeding border of the horizontal incision. Thus, the new lip contains the muscular fibres belonging to the orbicularis and its antagonists; it is covered behind by the natural mucous membrane, and this membrane may be turned over and united to the skin, so as to resemble more closely the natural feature.

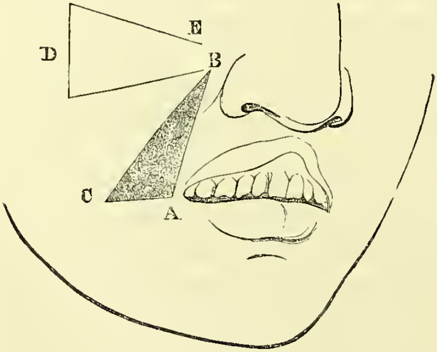
The modification of this operation commonly performed in this country corresponds in principle so closely to the above, that further reference is unnecessary.

Mr. Syme has introduced an operation by which the cancerous ulcer of the lower lip is first removed by two incisions, extending from the angles of the mouth to the chin, and uniting below, so as to include a piece of triangular shape. The cuts are then carried obliquely downwards and outwards on each side, under the body of the jaw, and made to terminate in a slight curve outwards and upwards. The flaps thus formed are detached from their subjacent connexions, and the whole raised upwards, so that the original triangular incision comes into a horizontal line, and is made to constitute the margin of the new lip; the secondary incisions, under the jaw, coming together in a vertical direction, in which they are retained by twisted and interrupted sutures.*

These operations are preferable to that of Chopart, who made an incision on each side of the tumour, vertically downwards over the lower jaw, according to the magnitude of the operation, even down to a level with the os hyoides. This quadrilateral flap is dissected off the bone, in its entire thickness; the parts morbidly altered are cut away by a transverse incision. The remaining portion of the flap is then raised to the proper level of the mouth, where it is retained by suture; the head at the same time being depressed, to diminish tension.

Restoration of the upper lip. Plastic operations to restore loss of substance in the upper lip are rarely necessary; one, and perhaps the chief reason being, that cancer is so extremely rare in this situation that few Surgeons have ever been here called upon to deal with its effects. With care a considerable amount of integument can be obtained from the cheeks, and united, as in the case of the lower lip, by sutures in the mesial line. The front teeth will thus obtain a covering and be protected from the cold, and the expression of the face will be much improved.

The first operation is that proposed by Von Ammon, who describes a shrinking of the upper lip, sometimes caused by prolonged salivation, by which the part is tightly stretched over the arch of the teeth, and sometimes adherent to the gums. This condition Von Ammon rectifies in the following way.†



The lip is first freed by a scalpel from the gum. Then an incision, A B, is carried upwards from the angle of the mouth, for about an inch and a half, towards the alæ nasi. The tense parts separate, and this longitudinal fissure becomes triangular in form, A B C.

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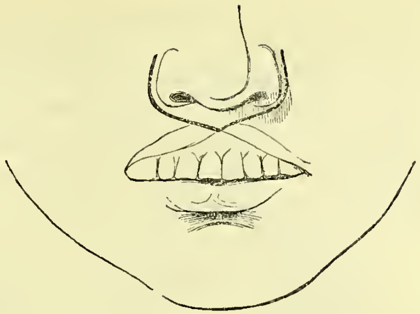
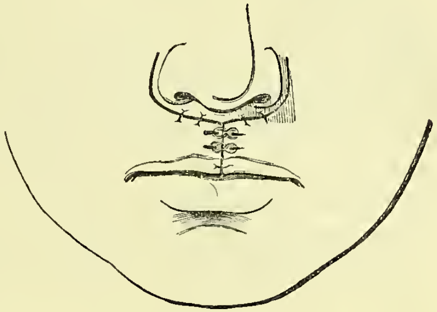
* *Edin. Monthly Journal*, 1847.

† Ammon und Baumgarten, *Plastische Chirurgie*, p. 155.

A flap of integument is then dissected from the cheek, B D E, and is brought down to fill up the space at the angle of the mouth. After the operation has been completed on one side of the mouth, it is to be performed on the opposite.



I have no personal experience of this operation. When the central part of the upper lip is destroyed, the two side portions become drawn up towards the septum and alæ nasi, and the incisor teeth are completely exposed. Dieffenbach rectified this deformity by bringing a sufficient amount of integument from the adjacent substance of the cheeks on either side. He carried an incision by the side of the alæ nasi, down through the red of the lip; he loosened each half, and, bringing them together in the mesial line, united them by hare-lip pins and sutures.



Plastic Operations on the Ear.

Defects of the external ear attract so little attention, and are in general so easily concealed by the hair, that plastic operations are rarely required. I have removed considerable portions of the pinna for warty and carcinomatous growths, and find that the wound heals best, and with less deformity than might be expected, without sutures or any dressing beside a piece of wet lint. Dieffenbach, however, has replaced a piece of the pinna removed by the stroke of a sword; but he took the flap from the adjacent region of the scalp, a part which Surgeons are for the most part slow to touch. Having pared the edge of the ear, he made an incision of parallel length and about the same level through the adjacent scalp; from either end of this incision, two short cuts were extended upwards. After hæmorrhage had ceased, the raw edge of the ear was united by suture to the corresponding edge of the scalp. Oiled lint was inserted underneath. At the expiration of three weeks, union being perfect between ear and scalp, the portion of requisite size was completely detached from the latter situation. It is said that the transplanted portion first became blanched, but soon regained the circulation and normal warmth. I have no personal experience in the proceeding. (See also p. 134.)

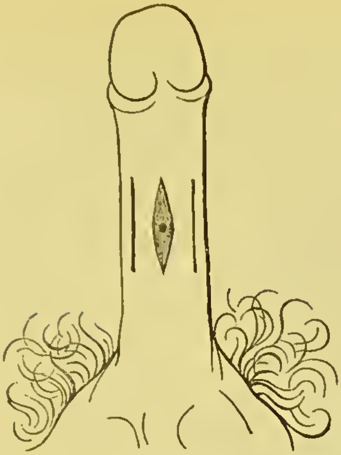
Plastic Operations on the Penis.

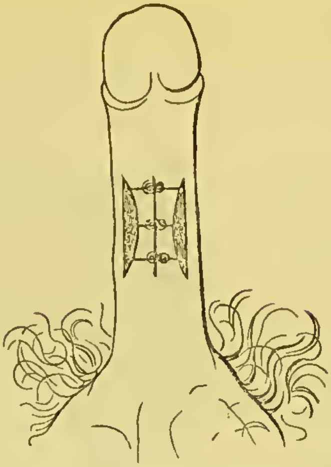
Plastic operations on the penis for deformities or imperfections, both acquired and congenital, are, as a rule, unsatisfactory in their results. Nature seems here able to effect a cure unaided by art, whenever the general conditions are favourable to recovery, or when the law of development has not been prematurely arrested. Thus fistulous passages in the urethra depend for the most part on strictures of the canal, which once properly dilated permit the ready cicatrisation of the artificial opening; and congenital deficiencies in the urethral walls usually indicate an imperfect condition of the canal beyond this point, but the tube is perfect so far as it is properly formed.

In the treatment of fistulous passages, whether near the scrotum or in the proximity of the glans, the careful employment of the catheter is the first measure necessary. The edges of the fistulous opening may after a time, if inactive, be stimulated by such remedies as tinctura cantharidis or nitrate of silver; but in the early stages all such applications are useless. Cases are seen in which, after the operation of lithotomy, a long fistula communicating with the urethra remains in the perinæum. Such a case I have treated successfully with galvano-cautery; *i. e.* by introducing a piece of wire the length of the fistula, and heating it by attaching it to the circle through which the electrical stream was passing.

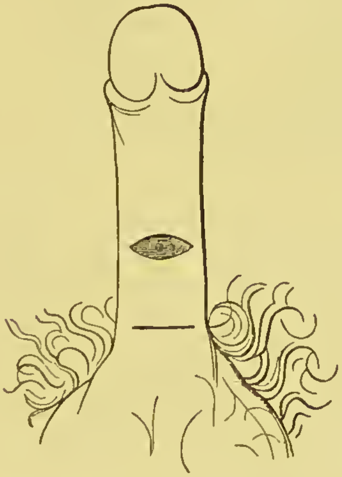
The simplest method of closing an opening in the urethra by a plastic operation is as follows:

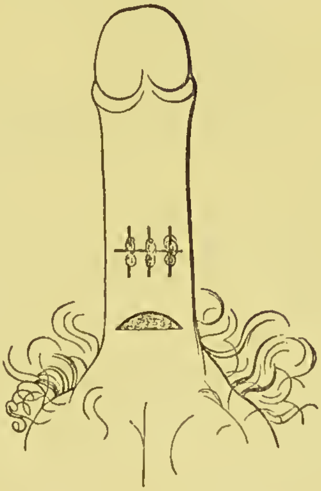
Operation. The Surgeon must dissect away a lozenge-shaped portion of integument from around the fistulous opening. He then brings the edges of the skin together with sutures; lastly, he makes a longitudinal incision on either side of the newly united wound to relieve tension. The operation is simple and easily performed, and looks well in a diagram. But there is difficulty in preventing the urine insinuating itself between the edges of the wound, causing the parts to reopen, or even leading to mortification of the flap.





The same remark applies to a similar operation in which the incision is made transversely, and the flap of integument is drawn from behind. There is no difficulty in obtaining skin enough, especially towards the root of the penis.





In cases of still greater defect in the walls of the urethra Dieffenbach has made transverse incisions through the integument before and behind the opening, and brought over it the intervening skin from the upper surface of the organ. But, inasmuch as the operation has not been promising in its results, I must refer the reader to that Surgeon's works for matters of detail. The operation of M. Alliot* is perhaps the most ingenious, and has moreover been reported as successful. He circumscribes and dissects a small quadrilateral flap; and taking away from the other side a portion of skin equal to this flap, he so covers the fistula and the loss of substance, that the principal sutures are at a distance from the urine when it traverses the urethra.

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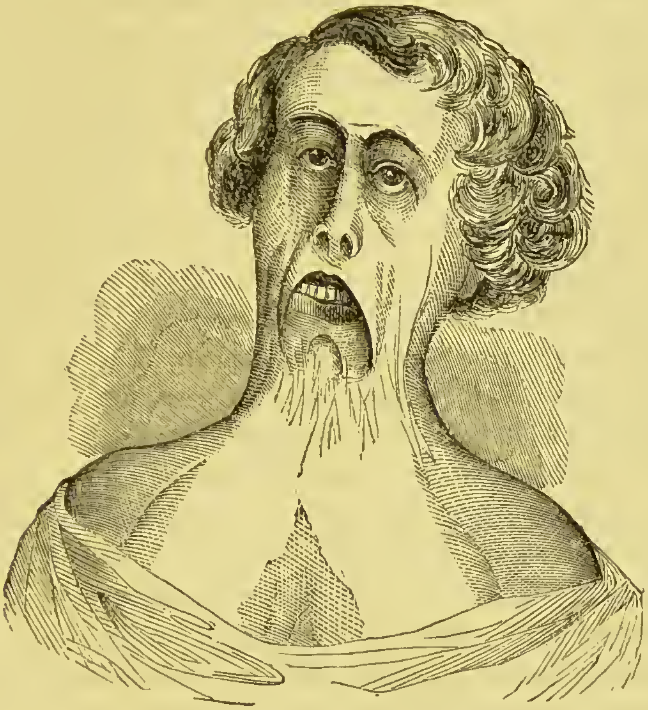
* Fritze, op. cit. p. 116.

On the Treatment of Contracted Cicatrices.

Within the vagina. The mucous membrane of the vagina is subject in infancy to a low form of inflammation, which terminates in sloughing of part or of the whole of its circumference. The separation of the slough, and subsequent cicatrisation of the wound, is followed by contraction of the cicatrix, and narrowing of the vagina at a variable distance from the os externum. These later changes often escape observation until the patient attains a marriageable age, when she finds connexion impossible, and the attempt extremely painful. The cicatrix, however, yields very readily; and the defect may, in many cases, be overcome immediately by the introduction of the fingers or any dilating instrument, the patient being under the influence of chloroform. But this proceeding is not unattended by danger; for if the cicatrix be rudely torn, a low form of pelvic cellulitis is set up, extending perhaps to the peritonæum, under which the patient sinks.

I cannot dwell too strongly on the dangers of violence in all such cases. No cutting instrument should be used; for the integrity of the walls of the vagina must be preserved, and a fresh cicatrix would, by its secondary contraction, lead only to further difficulties. No laceration by sudden violence is permissible, for inflammatory mischief may ensue therefrom. But sponge tents should be introduced, that the contracted orifice may be slowly, cautiously, and painlessly dilated, without laceration, but with gradual absorption of that peculiar material on which the firm dense part of an old cicatrix depends. The principle of gradual extension is one of the greatest improvements in modern surgery.

Cicatrices from burns, escharotics, &c. The application of heat or of powerful escharotics will either disorganise the superficial layers of the skin, or destroy its entire thickness. In the former case, cicatrisation is completed without deformity; in the latter, a secondary process, that of contraction, goes on after the new material is formed over the wound; and this contraction proceeds slowly, almost imperceptibly, and painlessly, but irresistibly save by mechanical treatment, until changes as regards the limbs most serious, and as regards the face most hideous, are produced. The smooth white cicatrix drags by its contraction on the surrounding integument, pulling it into folds, and puckering it up as towards a centre. It becomes itself elevated into knobs or tubercles, which seem to grow thicker and thicker the more complete the contraction. I know of no limit as to time when the patient can be pronounced free from further extension of the evil, especially among the young during



the important period of growth. No tissue is exempt from its influence, and even the bones undergo an alteration in form. In cases of severe burns about the neck, the chin is drawn down, the alveolar border of the jaw and the front teeth are everted, the nose is dragged to one side, the lower eyelid turned outwards, and, when the burn has affected one side more than the other, the whole bony frame-work of the corresponding side of the face has exhibited the marks of the contracting force.

Surgical ingenuity has been pushed to the uttermost to devise operations by which this distressing calamity may be removed; but I express the opinion of most Surgeons of experience of the present day, in affirming that hitherto all such operations have proved failures; and for this simple reason, that whenever an incision is made, a new cicatrix must be formed, and this new cicatrix will undergo precisely the same process of contraction as the former, which it was intended to alleviate.

It may be laid down as a rule almost without exception, *that a cicatrix should never be touched with the knife.* And we find that these operations have for some time past been discarded as useless at St. Bartholomew's, and some other leading hospitals of London.

The late Mr. Earle proposed to cut away the whole of the cicatrix, and then bring the edges of the healthy skin as much towards each other as possible, in the transverse direction, with strips of adhesive plaster. But in most cases this measure is impracticable, either from the situation of the burn, or from the amount of integument already destroyed. Who, for instance, could dissect away a large cicatrix from the front of the neck, and drag forward the skin from the sides and nape by means of strips of adhesive plaster passing over the larynx and trachea? The practice of detaching and transplanting a flap of integument has been recently revived by Mr. Teale of Leeds. But to this proceeding I would quote the words of Mr. Skey: "There is no difficulty in obtaining sound skin by autoplasm to supply the deficiency and to fill up the space caused by the division of the bridles; but the real difficulty consists in effecting its junction with the diseased parts, and in retaining its vitality, for the base of the wound so made is not to be deemed healthy, but, on the contrary, is greatly indisposed to coöperate with the skin laid down and to accept its union. It would appear that the vital force of this structure is too much exhausted in the struggle against the necessary agents of extension to participate in the healthy actions requisite for adhesion to the structure brought into apposition with it; and when we consider the adventitious nature of this tissue, and the probable condition of its vessels, the failure of these operations is not surprising; but this failure is by no means necessary or universal."* Mr. Skey has proposed to obtain extension of the cicatrix by means of a number of minute divisions both of the skin and subjacent tissue, founding his practice on what may be deemed, he says, an axiom in surgery, viz. *that the contraction of wounds is slight in proportion as the time consumed in the healing process is short.*† But even in this practice the secondary contraction inseparably connected with a newly-formed cicatrix cannot be avoided; and I therefore would direct especial attention to the method of treating these cases by mechanical extension alone.

When gentle yet constant traction is exerted on a hard and contracted cicatrix, it yields, without tearing, with singular facility; the hard knots disappear, the firm seams become soft and pliant, and the new skin regains the suppleness, though not the completeness, of the natural structure. After extension has been kept up a sufficient length of time, the material on which the contracting power depends becomes absorbed, and the elongation of the cicatrix is permanent.

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* *Operative Surgery*, p. 687.

† Op. cit. p. 688.

The results of this treatment are mostly satisfactory, and failure proceeds from want of patience, which substitutes forcible, and as it were spasmodic, efforts, for persevering and unremitting gentleness.

To the objection, that the system is tedious, I would reply, what can be more wearisome than the attempt to heal a large open sore following a divided cicatrix? The principle in all apparatus for such cases consists in slow extension, effected usually by means of the cogwheel. For the extension of a cicatrix in the neck we employ a pelvic band of steel, with two side-crutches and a webbing-band in front to keep the instrument steady; a posterior steel upright, to which is attached a headpiece with branches, movable in every direction by means of cogwheels and a strap passing under the chin.* Every day, or every other day, the smallest possible amount of extension must be made and maintained; but the patient should suffer no pain, nor must the skin be allowed to break. If a sore should form, the apparatus requires removal, and the advantages thus far obtained will be lost during the tedious cicatrisation.

The same remarks apply to the extension of the cicatrix of a contracted limb. The apparatus, modified according to circumstances, must be worked by a cogwheel, which insures steady, unremitting, and yet limited exercise of force. The hardened seams elongate and become soft, and the freedom of movement is regained far more speedily, effectually, and painlessly, than by any other means.

In slighter cases a great amount of benefit will ensue from direct pressure; a piece of vulcanised India-rubber is moulded exactly to the contracted part, and is retained there by a bandage, strap, or elastic roller. In the course of a few weeks the hardened seams become softer, and the integument regains its lost pliancy. This practice is useful in cases of contraction of the elbow in children; also in the treatment of contractions of the neck, especially in combination with the extending apparatus, when the chin seems lost in the deformity, and the teeth are assuming a horizontal direction.

HOLMES COOTE.

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* For details as to these instruments, see the Appendix: SURGICAL APPARATUS.

DISEASES OF THE EAR.

THE diseases of the Ear naturally divide themselves into three classes, in conformity with the anatomical structure of the organ—those of the external, of the middle, and of the internal ear. The first class includes the affections of the auricle and of the external meatus; the second, those of the membrana tympani, tympanum, mastoid cells, and Eustachian tube, with the adjacent regions of the throat; the third embraces the diseases of the labyrinth and of the auditory nervous apparatus, so far as it comes within the reach of our investigation. In addition to these, certain diseases not capable of strict local definition, and the effects produced upon the brain and other organs, chiefly the lungs, by inflammation commencing within the ear, will require description.

I. Affections of the External Ear.

Malformations. The Surgeon is occasionally consulted for external malformations of the ear. These vary in extent from an entire absence of the meatus and its appendages on the one hand, to the presence of a double set of organs on the other. The most frequent malformation is an imperfect development of the meatus and auricle; the former being reduced to a narrow slit in the temporal bone, and the latter existing only as a slight fold of the integument. The tympanum also, in some of these cases, is merely rudimentary, consisting of an irregular aperture a few lines in diameter, and the ossicula are more or less defective. Sometimes a single bone, resembling the columella of birds and reptiles, takes their place. The labyrinth is in these cases most frequently normal, and a certain amount of hearing is usually present; often it is so considerable as to enable the patients to perform useful duties. For the most part extensive deformity is present, from absence or defect of other portions of the skull, as the malar bone, or the zygoma; and the orifice of the meatus may seem to lie very much anterior to its normal position. Operative proceedings have not been found beneficial in these cases, nor in those in which, with a more or less perfectly formed auricle, the cartilaginous portion of the meatus is also perfect but ends in a cul de sac. The bone beneath is generally found solid. In another class of cases, however, in which the defect is confined to a contraction of the meatus at its orifice, from a falling back of the tragus, or projection forwards of the antitragus, efficient assistance can be rendered by the prolonged use of a tube adapted to the size of the canal; or excision of a portion of the offending cartilage. Congenital closure of the meatus by a false membrane, sometimes superficial, sometimes deeply seated, near the membrana tympani, is said to have occurred, and to have been remedied by the division of the structure, followed by the introduction of tents.

Supernumerary auricles are sometimes met with, growing from the sides of the neck. In the ninth volume of the *Transactions of the Pathological Society*, Mr. Birkett relates a case of this kind. The structures consisted partly of a tissue like the lobe of the ear, and partly of fibro-cartilage, the shape of which "resembled more or less closely, in parts, that of the proper auricle; and its tissues were the same." They were excised without difficulty, and appeared to be merely cutaneous appendages, not extending more deeply than the fibres of the platysma myoides.

Injuries of the auricle, and the lodgment of foreign bodies in the meatus, will be found treated of in the essay on INJURIES OF THE FACE.

The auricle is subject to various *cutaneous affections*, herpes, impetigo, pemphigus; but the most important are chronic erysipelas and chronic eczema. Both these conditions are most frequent in women past middle age, though the latter is also met with in children. In chronic erysipelas the entire auricle becomes greatly thickened, so that the outline of its various parts is almost lost. The skin is red, dry, and hard, and covered with desquamating epidermis. The swelling encroaches on the meatus, the orifice of which is narrowed and frequently obstructed with epidermis. There is constant itching, but not much pain, though the parts are tender. Sometimes the affection dates from a previous attack of acute erysipelas, extending over the side of the head; sometimes it seems to be local from the first. The health is invariably deranged. The *treatment* consists first in cleanliness, the discontinuance of wrappings, and free exposure of the parts to the air. When the inflammatory thickening and irritation are considerable, poultices may be applied at night. A continued use of astringent lotions is needed to restore the healthy action of the skin. A solution of nitrate of silver (gr. v.—℈j. to ʒj.), used alternately with others, has considerable effect. Glycerine is often very soothing; or the ear may be covered with collodion, renewed daily. The constitutional treatment should be conducted on the usual principles. Debility is generally, but by no means always, present. A permanent contraction of the meatus sometimes results from this disease. Its effects may be mitigated by wearing a small silver tube accurately fitted to the parts.

In chronic eczema the auricle presents less thickening than in the last-mentioned affection; but it is considerably swollen, covered more or less with brown or yellow crusts, and when these are not present exudes a watery fluid. A similar eruption is generally present on the scalp, or on other parts of the body. The diseased condition mostly extends into the meatus, and more or less deafness is present. It is attended with great itching. The *treatment* is the same as for other forms of eczema; but the meatus should be well syringed out with warm water frequently, to prevent discharge from accumulating within it, and in the later stages of the disease may be washed with a solution of the nitrate of silver, or with citrine ointment diluted with glycerine or almond oil. If, after the eruption has ceased, there remain any degree of hardness of hearing, dependent upon a thickening of the membrana tympani, the case would come within another class of affections—those of the middle ear.

Gouty deposits are frequent in the auricle; and congestion of the cartilage, arising from the same cause, is sometimes met with. Excoriations are not uncommon in children; but they are readily cured by cleanliness, with or without mild astringent lotions. Great care should be taken to dry the ears and hair of children after washing. In inflammatory affections of the auricle or meatus, the glands beneath the angle of the jaw generally become somewhat swollen and tender; occasionally suppuration occurs in them. Paralysis of the facial nerve may result from their pressure.

Tumours of the auricle. Of these, three chief forms have been described:

1. A fibrous growth of great hardness, forming in the cartilaginous portion, and giving rise sometimes to great inconvenience. This is rare in England, but in the American *Journal of Medical Science* for October 1860, it is stated to be much more common in

negroes. Fibrous tumours also form in the lobe, around the hole from which the ear-ring is suspended. In either case they are easily removed.

2. Cystic disease. Under this name two distinct affections have been described: one consisting of a sac containing a glairy tenacious substance, the other being an infiltration of the tissues of the auricle with a sanguinolent fluid. The latter is the disease met with so frequently in the insane, known under the name of hæmatoma auris. Whether this affection arises from injury, is still a matter of discussion among those who have charge of the insane. For treatment, Dr. Thurnam (as quoted by Mr. Toynbee) recommends, in the acute stage, "the use of evaporating lotions; at the end of a week or two a seton should be passed through the long axis of the swelling, and the contents pressed out. Under the use of the seton the tumour gradually subsides." In the treatment of the ordinary cysts, Mr. Wilde recommends that they should be laid freely open, and dressed from the bottom with lint.

3. Steatomatous and fatty tumours are also met with in the auricle, as well as a pendulous state of the lobe, which may reach an extreme degree, especially if goitre be present. This part is also subject to nævus, which may lead to its destruction to a greater or less extent; and erectile tumours have been met with in it, causing hæmorrhage. The latter affection will be treated of in the section on Vascular Tumours.

II. Affections of the External Meatus.

In some cases in which this passage is wide and short, the greater part of its extent can be examined, and the membrana tympani rendered visible, by placing the patient in a good light, and gently elevating the helix of the ear with one hand, while the tragus is drawn forward with the other. For the most part, however, this is not possible, and a speculum is necessary. The best form of speculum I believe to be a silver tube, which is made of oval shape to fit the oval form of the meatus, and has its smaller end continued of the same diameter for about half an inch. This instrument, if of a suitable size (and it is desirable to possess two or three of different sizes), admits the largest possible amount of light, and adapts itself easily and painlessly to the canal, in which it will remain fixed while the Surgeon's hands are free. By moving it slightly in different directions, the whole of the inner part of the meatus and of the surface of the membrana tympani can be minutely examined. The most perfect view of the parts is to be obtained by causing the rays of the sun to fall through this speculum into the meatus, which may be effected by placing the patient in the sunlight, with his head inclined at a suitable angle; but when the direct rays of the sun are not available, an artificial illumination is necessary. This may be supplied either by means of a jet of gas conveyed by a flexible tube to a small stand furnished with a reflector, or by a reflector attached to an ordinary candle, or by means of the very convenient lamp invented by Dr. Chowne, and known as Miller's lamp. Whichever of these methods is used, the speculum should be gently introduced into the meatus, and the light directed by the reflector to the bottom of the canal. In young children the meatus is very shallow, the osseous portion consisting only of a small ring of bone (deficient at the upper part), to which the membrana tympani is attached. The speculum, therefore, should be used in their case with great caution. The points to be noted in the examination of the meatus are, the size and calibre of the canal, whether normal or infringed upon; the presence or absence of extraneous bodies and of cerumen; the characters presented by the latter, if present; and the condition of the lining membrane.

Accumulation of cerumen. Though a very frequent affection, impaction of wax in the meatus does not constitute so large a proportion of the causes of deafness as might have been supposed. From my own notes, the proportion of cases benefited by the removal of cerumen would appear to be about one in six. But the presence of wax is only in a minority of the instances in which it occurs the sole cause of the deafness that accompanies it. Mr. Toynbee found a perfect restoration of hearing effected by the removal of cerumen in sixty ears only out of 165.

Besides interfering with the hearing, accumulations of hardened wax may produce various ill effects. They may occasion (probably through pressure on the membrana tympani and ossicula) very distressing nervous symptoms; not only "noises in the head" of various kinds, but giddiness, confusion, and even unsteadiness of gait, exciting the gravest apprehensions in the patient's mind. Further than this, they may even cause absorption of the bony walls of the meatus. This occurs especially in the old, in whom neglected accumulations have existed for many years. In some cases of this kind the osseous plate that separates the cavity of the meatus from that of the mastoid cells is completely penetrated.

Deafness caused by cerumen for the most part presents peculiar symptoms, and a tolerably good diagnosis may often be based on the description and history of the case. The hearing generally varies; it is often better in the morning, and is improved by eating, or by rubbing the meatus with the finger. Very often it comes on suddenly, especially after exposure to cold. This is probably due to slight inflammatory swelling taking place in the meatus, and converting a partial into a complete occlusion. This circumstance has frequently led to the employment of the most misplaced depletory and other treatment in cases in which an inspection of the meatus has not been made. There is, however, another form of deafness which comes on suddenly after exposure to severe or long-continued cold, or cold and wet, and appears to depend upon an abolition of the function of the nervous apparatus. The great degree of the deafness, however, compared with the slightness of the apparent cause, together with the previous history, may serve to distinguish the effect of cerumen from the last-named affection. But however characteristic the symptoms may be, an examination of the passage should always be made; and if cerumen be present, it is to be removed by syringing. The most efficient form of syringe is one fitted with a separate nozzle of small size, since a very fine jet of water acts much more effectively in dislodging the mass, and presents less obstruction to the returning stream. The nozzle should be taken off each time the syringe is filled, and replaced before it is used. If this form of syringe is not used, care must be taken that the meatus is not obstructed by the instrument. In syringing, the meatus should be straightened, by drawing back the auricle with the left hand, and gently pressing forward the tragus by resting the nozzle of the syringe upon it; and the ear-spout—a sort of funnel to be placed beneath the ear and retained by a spring passing over the head—or a tin basin fitting to the side of the neck, are very convenient. Whatever fluid is used, care should be taken that it is sufficiently warm. The patient's own feelings should regulate the temperature, but it should never be below that of full blood heat. If cold or even cool fluids are injected into the meatus, great giddiness is produced. In ordinary cases, warm water only need be used. If the wax is soft, it speedily comes away; but when hard, its removal may require great perseverance. The use of the syringe should never be carried beyond a moderate extent at any one time, and should be immediately discontinued if the patient complains of pain. It is much better to repeat the process several times than to run any risk of producing irritation, the effects of which are sometimes very difficult to allay. Cases occur in which the most distressing and obstinate noises in the ears have supervened upon the removal of wax by the syringe; and in some of these I have found that even the most gentle employment of that instrument tends to aggravate the symptoms. If the wax is not removed in a moderate time, warm oil or water introduced for a few nights will generally sufficiently soften it to render its evacuation easy. This, however, is not always the case; sometimes the altered cerumen, mingled as it is with epidermis, is of almost stony hardness, and the parts at the same time are acutely tender, so that the most prolonged and gentle treatment is necessary to give relief. Whenever the syringe is employed, the ear should be frequently examined with the speculum, to ascertain whether any wax remains; since although the last portion generally comes away in a large mass, presenting a cast of the membrana tympani, this is not always the case. Small masses of hard cerumen sometimes collect in contact with the membrana tympani, and occasion much annoyance, in the form of itching and tinnitus. The speculum reveals the nature of the case, and syringing, which sometimes needs to be repeated, relieves it. A similar irritation may follow from the falling in of a hair upon the membrane; but probably in these cases there already exists a morbid irritability of the organ.

After the removal of cerumen, the membrana tympani is generally seen to be of a more or less sodden and opaque appearance, from thickening of its epidermoid layer; sometimes it is red and vascular. In a few days, however, if no other disease be present, it recovers its normal appearance. When the hearing is perfectly restored at once, the patient perceives sounds with great intensity, so that the voice, or the noises of the street, may even painfully affect him. In this case a portion of cotton-wool may be worn over the meatus for a few days, by which time the excessive sensitiveness will have abated. Indeed, it is perhaps better in all cases to guard the passage with cotton-wool for the remainder of the day, at least if the patient be exposed to atmospheric changes. In many cases the hearing only gradually returns; and sometimes, when the immediate improvement has been but slight, it will rise by degrees almost to its normal amount. Time should therefore be allowed for this result before other measures are adopted.

This affection is apt to return; nor have I seen sufficient evidence to show that any applications to the meatus can ward it off.

Besides accumulation, the secretion of wax is subject to other disorders. In children it may become increased in quantity, fluid, and offensive; this being often the first stage of catarrhal inflammation of the meatus. In adults it is frequently entirely absent; but this is for the most part merely a concomitant of internal morbid conditions, and is itself entirely without influence on the function of the ear. Sometimes, though not always, the reappearance of the normal secretion attends or prognosticates a favourable issue of the case.

In the majority of the cases in which accumulations of wax are found, there exists also a *desquamation of the epidermis*, and it is not uncommon to remove large masses of the latter, more or less mingled with cerumen. Sometimes an obstinate tendency to desquamation exists without any other apparent affection of the meatus, and this may or may not be accompanied by disease of the internal or middle ear. It may occur in connexion with a general morbid irritability of the organ, or with tinnitus; and in the latter case the irritation of the loose masses of cuticle may aggravate the noises to a most distressing degree. The treatment in such cases must embrace the improvement of the general health and the strengthening of the nervous system. Local applications require to be very carefully employed. The ordinary astringents are ill borne. In this respect the condition differs from the common chronic inflammation of the meatus. A few drops of oil applied occasionally facilitate the removal of the flakes.

Abscess in the meatus. This is an acutely painful, though not otherwise serious affection. It occurs generally in persons about middle life, and consists in the formation of a small circumscribed abscess in the outer part of the meatus, apparently having its seat in the ceruminous glands. Sometimes only one abscess forms, sometimes several. The affection is apt to recur, and may coincide with the formation of boils in other parts of the body. While the abscess is forming, there is acute pain of a throbbing darting character in the meatus, often extending over the side of the head. The parts are extremely tender, and the attempt to introduce the speculum causes great distress. The meatus is tumid, and its aperture narrowed; the swelling of the abscess is generally visible near its outer part. The hearing may be temporarily impaired by narrowing or even closure of the canal. The density of the structures and their copious nervous supply account for the severe pain, which sometimes gives rise to considerable fever. Relief is given by the free use of poultices and fomentations, which should be applied as hot as they can be borne. In a few days the abscess bursts, and the symptoms abate. Purgatives, and depletion by leeches, may be employed in the severer cases. By some authors it is recommended that the abscess should be opened; but the extreme pain of the incision is a practical objection, unless chloroform be given. In almost all these cases a similar constitutional treatment is indicated as for "boils" on other parts of the body. When there has existed a tendency to their continued recurrence, the sesquioxide of iron in free doses has appeared to me to be useful.

Inflammation of the meatus. This affection is either acute or chronic; it is frequently connected with diseased conditions of other parts of the ear, the membrana tympani, tympanum, and mastoid cells, but it sometimes exists without the presence of more deeply-seated disease, especially in its earlier stages. Neglected inflammation of the meatus, aggravated as it constantly is by confined and decomposing discharges, has a great tendency to spread inwards, and involve the mucous membrane of the tympanum. This is especially the case in children, multitudes of whom may be seen among the poor, cachectic, half-nourished creatures, in whom an inflammation of the meatus, attended with discharge, has caused perforation of the membrana tympani; and the whole cavity of the meatus and tympanum is red, swollen, pulpy, and filled with an offensive acrid discharge, which ulcerates the orifice of the passage.

The early symptoms of *acute* inflammation of the meatus are similar to those which characterise the formation of abscess. The pain, however, is generally less acute; it is of a dull aching character, and is increased by motion of the jaw. On examination, the meatus is found tumefied and tender, its surface is red and vascular. After repeated attacks, it may be so swollen as almost to obliterate the canal, but no local swelling is to be observed. The neighbouring glands of the neck are often enlarged and tender. The hearing is not much impaired unless the canal is almost closed, or the tympanum is implicated. The health is almost always disordered, and some of the severest and most obstinate cases I have seen have occurred in patients subject to gout. The access of the disease is generally attributed to cold, or blows on the head may occasion it. Sometimes there occurs at an early period of the affection an extremely profuse watery discharge, almost equal to that which follows certain fractures of the skull; sometimes the inflammation subsides without any discharge; sometimes it is followed by a secretion of viscid mucus or of pus; or it may run into the chronic form of the disease.

In the *treatment*, the mere cleansing the meatus with warm water gives great relief, which is increased by hot fomentations and poultices, and it is probable that in some cases these means might suffice. The health, however, is generally more or less deranged, and the constitutional remedies either for debility or visceral derangement are indicated. Often also the severity of the pain demands local depletion, by leeches, around the orifice of the meatus (the passage being guarded by cotton-wool), and the employment of morphia in full doses to give rest.

The acute inflammation of the meatus, like the formation of abscess, is prone to recur, and great care is needed on the part of those who are convalescent from it to escape a relapse. Exposure to draughts should be carefully avoided, while at the same time exercise should be taken, and the ear should not be kept wrapped up. The general health, deranged before, seems almost always more shattered by the attack of aural disease, and should be recruited if possible by rest or change. The vapour or Turkish bath seems likely to be useful in these cases. Stimulants should be very sparingly employed. After the inflammatory action has subsided, the ointment of the nitrate of mercury diluted with oil may be smeared over the surface of the meatus, or a solution of the nitrate of silver, five or ten grains to the ounce, applied with a camel's-hair brush.

Chronic inflammation of the meatus sometimes follows the acute form of the disease; sometimes it results from repeated slight attacks of inflammatory action. A common cause of it is the habit of prolonged bathing, or damping without drying the ears or hair. Without any considerable amount of pain, a feeling of uneasiness in the passage is complained of, a sensation of tension, and often of itching, prompting the patient to introduce pins or other substances with the view of allaying the irritation. This practice of course maintains and aggravates the disease. The meatus is swollen, and the epidermis becomes thick and peels off, often accumulating to a great extent. Sometimes the entire cuticular lining of the canal becomes loosened, and may be withdrawn in a form resembling the finger of a glove, the inner extremity presenting an accurate cast of the membrana tympani. In the worst cases the walls of the meatus are of a dusky-red colour beneath the epidermis, and tender. The wax is deficient, the hearing is most frequently impaired, and the membrana tympani vascular on its external surface. Indeed, this condition of the meatus, though it is met with alone, seems seldom to exist without disease affecting also some of the more internal structures of the ear. In children this form of disease is much less frequent than one attended with profuse discharge. The cure is difficult; counter-irritation by any of the various derivants over the mastoid process seems to be useful, and should be maintained in a mild form and with intermissions for a considerable period. At the same time the syringe should be employed to free the meatus from the desquamating epidermis, which oil or glycerine applied at night will aid in detaching. Astringent lotions, such as a weak solution of acetate of lead or nitrate of silver, or two grains of the chloride of zinc to the ounce of water, may be applied with advantage.

Another form of chronic inflammation of the meatus is accompanied by discharge, generally to a large amount. This is sometimes distinguished under the name of "catarrhal." It is most frequent in children, and in the mildest cases constitutes one of the commonest forms of "ear-ache." After a slight access of pain there follows a thin discharge from the meatus, which is often at first dark-coloured, as if consisting of altered wax. Cleanliness by syringing, with frictions around the ear, &c., generally suffice to restore the healthy condition of the parts. The meatus appears pale and sodden; it is slightly tender, and the epidermis of the membrana tympani may be thickened. The probable cause is cold.

The severer form of this affection may arise from repeated attacks of the milder kind if cleanliness be neglected, or may remain as the result of acute inflammation, or may follow measles or other febrile affections, though for the most part there is then also inflammation within the tympanum. It may also be induced by irritating applications, or in unhealthy constitutions may arise without assignable cause. There exists a more or less copious discharge, which is of a milky or flocculent character, but which may be distinguished from discharge escaping from the tympanum through rupture of the drum by its never presenting a stringy or ropy appearance when mixed with water. This fact was first pointed out by Mr. Toynbee. The discharge is often very offensive. Pain is seldom complained of. The meatus, when cleansed and examined by the speculum, is seen to be swollen and soft, and for the most part red. In the majority of cases the membrana tympani is opaque or vascular. In the treatment, cleanliness has the first and most important place. The meatus should be thoroughly washed out by the syringe and warm water, at first twice a day, or oftener if necessary, then every evening, and afterwards at longer intervals as the discharge diminishes. Also if, as is frequently the case, the patient have been in tho habit of wearing cotton-wool, so as to prevent the escape of the matter, and convert the meatus practically into an abscess, this should be at once discontinued, and the parts restored to their normal relation to the atmosphere. These means alone will often suffice to effect a cure, especially in children; for in many instances the morbid action appears to be kept up entirely by the exclusion of the air, and the irritating effect of the accumulated discharge.

If, however, the disease do not subside under this plan, or though improving yet stop short of perfect cure, an artificial discharge may be established by mild counter-irritants over the mastoid process (the vesicating paper is very convenient), and astringent lotions injected. These should be weak; from two to four grains of alum or sulphate of zinc to the ounce of water. They may be either injected with the syringe, or dropped in after the passage has been washed out with water, being always used warm. In the more obstinate cases, a lotion containing acetate of lead may be applied at night to the orifice of the meatus on cotton-wool, or the nitrate of silver in solution washed over the canal twice a week. I have sometimes found glycerine diminish the discharge when the mildest astringents seemed to produce irritation.

The health being almost always deranged, especially in children, tonics are indicated; quinine, iron, and cod-liver oil. Mr. C. Forster speaks very highly of the effects of chlorate of potash given in free doses. Often the state of the throat requires attention. And in every case the greatest regard should be paid to general hygiene. It will be necessary also for the Surgeon to instruct the patient or his friends in the mode of using the syringe. The most frequent error made by those who are unacquainted with anatomy is that of placing the nozzle of the instrument obliquely to the side of the head, in a direction corresponding with that of the tragus, instead of placing it at right angles and pressing the tragus forwards. The most convenient form of syringe for private use is an india-rubber bottle containing about two ounces.

Either of the above-described forms of inflammation may, in unhealthy subjects, extend to the osseous walls of the meatus, and give rise to caries or necrosis. This result is chiefly apt to occur in cachectic children.

Sometimes a considerable part of the wall of the meatus or of the mastoid process will come away; and it is remarkable to how great an extent this may take place without any considerable impairment of the functions of the ear. With the view of averting the extension of the disease inwards, the greatest care should be taken to secure a perfectly free exit for the discharge. A peculiar affection is mentioned by Kramer under the name of inflammation of the periosteum, commencing without pain, as a red spot at the lower part of the meatus, and rapidly running on to necrosis; but I have not seen this form of disease.

Syphilitic disease of the meatus. This occurs chiefly in the form of fissures or of condylomata around the orifice. But I have seen another condition which appears also to be due to the specific poison. The meatus is ulcerated at its outer part, the ulcer having irregular edges and a foul surface, and a copious discharge flows from the passage. When it is cleansed, the speculum shows its surface reddened, and excoriated in parts; the membrana tympani is vascular. I suspect the disease results sometimes from the direct application of the poison. The treatment would be conducted on ordinary principles.

Polypi. These growths being most frequently seated in the meatus, this seems the proper place to mention them, though they are also met with growing from the surface of the membrana tympani, and from the inner wall of the tympanum when that membrane is perforated. They occur in a considerable proportion of the cases of long-continued discharge from the meatus, whatever may be the nature of the affection which causes it. They are often symptomatic of disease seated within the middle ear; inflammatory affections of the membrane lining the tympanum or mastoid cells, for example, or closure of the Eustachian tube. If not originally due to these affections, they will at least very frequently return again and again after removal, unless the internal disease is cured. These growths also often coexist with suppuration in the tympanum, which is causing or threatening serious disease of the brain; and in these cases they require special attention. On the one hand, a rash or violent mechanical treatment of them might be extremely dangerous; and on the other, they may, by filling the meatus and preventing the escape of pus from the tympanum, be themselves the causes of the dangerous symptoms, and their careful removal may be the only condition of the patient's safety.

Polypi may spring from any part of the meatus, but they are generally attached to its upper wall near the membrana tympani. They may be very small, or may constitute bulky growths, which fill the entire meatus and project beyond its orifice. When large, they may cause, apparently by pressure on the membrana tympani due to their compression by the walls of the tube, many of the slighter symptoms of pressure on the brain, similar, in fact, to those which may result from the presence of hardened wax. Pressure applied to a polypus projecting externally has produced complete insensibility. These growths always exude a purulent, and generally offensive, discharge, and may give rise to occasional bleeding from the meatus.

Aural polypi have been variously classified; but the usual divisions of polypoid growths into fibrous and vascular seems to be sufficient for all practical purposes. There is met with, however, in the ear a third form of growth, a small rounded mass of cells, which may be termed a polypus, and yet requires to be distinguished from the other two, as not demanding the same treatment.

The ordinary vascular polypus "consists of numerous round heads attached by small filaments to a central stem. When examined microscopically, it is found to be composed of small rounded cells." The fibro-gelatinous polypus forms large rounded masses covered by a thick layer of epithelium, which may be separated from it by maceration, and consists of "corpuscles and fibrous tissue, varying in proportion in different specimens; but the fibrous tissue generally predominates." In addition to these elements there is sometimes present a structureless gelatinous substance, which may constitute almost the entire mass, and a number of spindle-shaped crystals.*

Kramer mentions a case in which a polypoid growth was of bony hardness; and the fibrous polypi are sometimes so dense as to be cut with difficulty.

The third form of polypus is simply a rounded mass of cells attached by a pedicle, almost always to the upper part of the meatus, just in front of the membrana tympani. It seems to be confined to children, frequently ensuing upon diseases of the tympanum produced by scarlatina or the other diseases of childhood.

Besides these polypi, which have distinct pedicles, granulations may form in the meatus, sometimes connected with diseased bone, and disappearing when the cause of irritation is removed. Sometimes also malignant disease, deeply seated within the petrous bone, may make its appearance in the meatus in the form of a fungoid growth. This is generally of a livid colour, unlike the bright red hue of polypus when situated within the meatus, or the pale glossy surface it may present when it approaches the orifice. The general cachexia also, which is always present in malignant disease, will aid the Surgeon in forming his judgment.

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* Mr. Toynbee, *Diseases of the Ear*, p. 95. It does not seem to me by any means impossible that these formations should differ slightly in character in different countries.

In the treatment of polypus two objects are to be sought: the complete removal of the growth, and the correction of the morbid condition with which it is associated. Of these the latter is the more important; indeed, until it is attained, the removal of a polypus is merely palliative; it is almost sure to return, or fresh ones will develop. It is also desirable, as a rule, not to interfere with polypoid growths until all irritation has been subdued, unless, as before mentioned, there is reason to believe that its presence is obstructing the escape of discharge. It should be remembered, too, that polypi will frequently disappear, or even come away in mass, under the practice of simple syringing with warm water, with or without other applications. This result, however, cannot be calculated upon, nor are ordinary astringents of any use; and in a large number of cases polypi require to be removed by operation, or otherwise destroyed.

The three forms of polypus above described are amenable in this respect to different treatment. The small globular polypus may be caused to disappear by strong astringent lotions; the common vascular polypus may be either destroyed by the direct application of caustics, or removed by suitable instruments; the fibrous requires mechanical removal.

The first-named growth presents a very characteristic appearance, hanging down like a red curtain in front of the superior portion of the membrana tympani, and presenting a clearly-rounded boundary. It is necessary, however, to distinguish these cases from those in which the membrane is partially destroyed; and the thick red mucous membrane of the tympanum is seen beyond it, or even sometimes—so tumid may it become—almost projecting through the orifice. This point can be absolutely determined, if the Eustachian tubes are pervious, by the use of the otoscope; but the position of the polypus, concealing the entire upper part of the membrane, and the absence of all appearance of the malleus in front of it, serve also to distinguish it. If no irritability remains, there may be applied to the meatus in this case a few drops of a solution of acetate of lead (from six to twenty drops to the ounce), or of acetate of zinc (one or two scruples to the ounce), or of sulphate of copper (four or six grains to the ounce), or of a solution of tannin. These may be dropped into the ear, after it has been syringed out with warm water, once or oftener a-day; and a piece of cotton-wool dipped in the same lotion may be worn at night. Under this treatment, the polypus will diminish and disappear; but this alone by no means suffices for the restoration of the hearing, which must be sought by whatever means the condition of the internal structures may demand. Of course, if the membrana tympani be ruptured, it is undesirable to introduce these powerful astringents in the fluid form. And in that case, the nitrate of silver may be applied in substance to the growth by means of a flexible probe.

For the removal of the vascular polypus, Mr. Toynbee recommends the use of a most ingenious instrument, which he terms the lever-ring forceps. It is introduced with the rings apart, and when the polypus is included between them, they are brought together by a slight movement; the softest and most pliable tissue can be thus removed. This is certainly the best method by far of destroying this form of polypus; but the ordinary wire-snare may also be used for the purpose, though it is much more difficult to apply. It has the disadvantage also of cutting through the root of the growth rather than drawing it away. This polypus may also be destroyed (though the operation requires much care) by strong caustics, such as nitric acid, or potassa cum calce. The latter may be made in thin sticks, and applied through a glass tube introduced into the meatus, warm water and a syringe being close at hand to syringe out the meatus immediately on the completion of the operation.

The removal of the fibrous polypus is easily accomplished; a forceps armed with small rings, or otherwise expanded extremities, is all that is required. The growth, being firmly grasped, is to be steadily but cautiously twisted off from its attachment.

The application of the nitrate of silver to the root, or injections of iodine, &c., are much insisted on by some writers, with a view to prevent the recurrence of the growth. It is doubtful whether any benefit is thus obtained. The strong nitric acid appears more effectual; but experience seems to lead to the conclusion that if the disease from which the polypus resulted be cured, it does not return; if such disease continue, the polypus will most probably be reproduced. An apparent return of a polypus, however, is sometimes caused by the existence of more than one at the time of the removal. It is frequently the case that several smaller growths are attached to the root of a large polypus, and take on a process of development when the latter is removed.

Sebaceous or molluscous tumours are enlarged sebaceous follicles containing scales of epidermis, which form occasionally in the meatus. If their progress be unchecked, they are apt to destroy life by causing absorption of the bone and pressing on the brain.* They may exist and even prove fatal in early life, though they are most frequent in the old. They are generally attended with discharge and pain. The treatment would consist in laying open the swelling, evacuating the accumulated laminæ of epidermis by the syringe, and then withdrawing by means of a forceps the thick membrane lining the tumour.

Exostoses sometimes form in the walls of the meatus; these may grow from either of its surfaces, and cases are not unfrequently seen in which two or more of such formations approach each other towards the mesian line. The hearing is impaired in proportion to the closure of the canal. Cerumen or epidermis may accumulate behind these growths, and will then require great patience, and a persevering use of fluids adapted to soften the mass, in order to effect its removal. This form of exostosis may occur in comparatively early life. Treatment is not so inefficacious as might have been feared. I have seen a severe case, in which the application of tincture of iodine seemed to induce a diminution of the tumours, and improvement of the hearing. Mr. Wilde speaks confidently of the power of local depletion, counter-irritation, and mercurials to arrest their progress in the early stage, when there probably exists a chronic state of periostitis.

III. Affections of the Membrana Tympani.

The membrana tympani is a thin colourless diaphragm, stretched obliquely across the inner extremity of the meatus. In its healthy state it is almost transparent; it reflects light strongly, and, owing to its peculiar curvature, presents a bright spot of triangular shape at its lower and anterior portion. This spot becomes obscured or altered in disease. Although the membrane is freely permeated by blood-vessels, which become turgid in congestion or inflammation, and may give it a deep red colour, none are visible in its normal condition. Its external surface is concave, with the exception of a narrow ring around its border. For practical purposes, the membrana tympani may be considered as consisting of three laminæ—dermoid, fibrous, and mucous; each of which may present distinct morbid conditions. In the diagnosis of its diseases, the chief aids are the speculum and lamp, by means of which its external surface may be examined. Inflation of the tympanum through the Eustachian tube, the mouth and nostrils being closed, may also be had recourse to; certain effects of the pressure of air on the internal surface of the membrane indicating tension, relaxation, rigidity, or ulceration of its layers.

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* Our knowledge of this affection is entirely due to Mr. Toynbee, *Path. Soc. Trans.* vols. ii. xi., *Med.-Chir. Trans.* vol. xliv. p. 51. Mr. Toynbee now prefers the name "sebaceous tumours."

In addition to the diseases which directly affect its own structure, the membrana tympani is often secondarily implicated in morbid conditions of more internal parts, and its appearance may give most important aid in their diagnosis. Thus, in obstruction of the Eustachian tube the membrane is drawn inwards, its natural concavity being increased, and the polish of its surface diminished. Mucous or other accumulations within the tympanum may, on the other hand, cause it to bulge outwards; and the presence of an opaque fluid in that cavity may sometimes be clearly recognised, especially in children, through its transparent structure.

Injuries of the membrana tympani. This membrane is liable to be accidentally ruptured from various causes, as the introduction of pointed instruments, a fall, or very loud sounds, such as the explosion of artillery, especially if occurring unexpectedly, so that the membrane has not been prepared for their reception by its adjusting muscles. A box on the ear, of which no warning has been given, will also produce the same effect, apparently by causing a compression of the air in the meatus, without the membrana tympani receiving the necessary state of tension. Sportsmen are liable to this accident from the report of their guns. Undue force of syringing, violent blowing of the nose, vomiting, paroxysms of hooping-cough, also have caused rupture of the membrana tympani; but in these cases there is little doubt that the membrane was previously weakened by disease. It may give way in death by strangulation. The symptoms of this injury are pain, generally not severe, felt at the bottom of the meatus, soon followed by the appearance of a few drops of blood. The hearing is not necessarily impaired. If an examination is made shortly after the accident, a small clot of blood may be seen closing the wound, which is generally from a line to a line and a half in extent. In the majority of cases it heals speedily, and without any further symptoms. The clot falls off in the course of a few days, but a white cicatrix is visible for a long time. Occasionally, however, ulceration is set up, or a small portion of the membrane seems to slough, the aperture increasing in size for some days. In all the cases I have seen, however, in which the rupture has occurred in a healthy membrane, perfect repair has finally ensued, and without injury to the function of the organ. In the treatment, it is for the most part only necessary to guard the natural process of repair from interruption. It may be advisable, however, if there be discharge, cautiously to cleanse the meatus by the syringe. A leech or two may be applied to the orifice of the meatus if irritation be present and the orifice seem extending, or the edges of the wound may be lightly touched with nitrate of silver. Indeed, under this latter plan, small orifices in the membrana tympani, that have existed for some time, will sometimes heal.

Inflammation of the membrana tympani. Frequently the epidermis covering the external surface of this membrane is thickened and opaque, no other morbid condition being present. This is of no importance pathologically, but it is a frequent cause of what is described merely as "opacity of the membrana tympani," which in itself is of course not a cause of deafness. Congestion of the membrane may arise from exposure to cold; it is attended with a feeling of slight uneasiness inside the ear, and sometimes with buzzing noises; and on examination, enlarged red vessels may be seen on the surface. Avoiding exposure, stimulating liniments, and warm oil dropped into the meatus, generally suffice for relief.

The *dermoid* lamina is subject to acute and chronic inflammation.

Acute inflammation is not common as an isolated affection, but it seems to occur sometimes from the application of cold or irritating substances in debilitated constitutions. The symptoms are pain, not very severe, generally attended with tinnitus and some diminution of hearing. The surface of the membrana tympani becomes of a red colour, large and distended vessels being visible; it appears swollen also, and there is sometimes a secretion from it of viscid mucus. I have in one case, that of a child suffering from scarlatina, seen a small abscess form in this layer of the membrane. It discharged itself, and healed without permanent injury to the hearing. For the local treatment, one or two leeches may be applied to the orifice of the meatus; gentle syringing with warm water should be employed; and in the later stages mild astringents or a weak solution of the nitrate of silver may be had recourse to.

Chronic inflammation of the dermoid lamina may remain as an effect of the acute form; may arise from cold or other causes in weak or neglected children; may supervene in the course of, or after, the exanthemata; or may coexist with affections of the skin in other parts of the body; or with inflammation of the meatus. It occurs chiefly in the class of patients termed "strumous," and is said to have been observed to alternate with strumous ophthalmia. It is attended sometimes with a rather copious mucous discharge, at others with an excessive secretion of epidermis, which may accumulate in thick scales upon the surface of the membrana tympani, and give rise to deafness and great irritation. These scales may be removed by syringing, or, if difficult to dislodge, may be softened by the use of warm oil or water. The membrana tympani in some of these cases becomes greatly hypertrophied, and granulations of a bright-red colour, and easily bleeding, may form upon its surface. This affection is generally painless; but in the severer forms the hearing is always much impaired. In the treatment, cleanliness should be maintained by the syringe, and the greatest attention paid to the state of the health, which will almost invariably be found more or less deranged. In children, quinine, steel, and cod-liver oil are almost always useful. Sponging, friction of the skin, and other points of hygiene, require attention; and with these, local measures may be combined. Vesication may be kept up, gently, behind the ear, and astringent lotions dropped into the meatus; or the membrane may be washed over with a solution of ten or twenty grains of the nitrate of silver to the ounce of water. But before having recourse to any topical applications, it is desirable to give cleanliness, combined with good general treatment, a fair trial. A considerable improvement seldom fails to ensue. Ulceration of this layer of the membrane sometimes occurs. It is generally confined to a small extent, and demands no special treatment.

That inflammations of this layer of the membrana tympani are sometimes *specific* in their character, can hardly be doubted; but no distinctive marks of the presence of the syphilitic, or scrofulous, or gouty taint, have yet been pointed out in the diseased structures. The diagnosis must be determined by the history and the general condition of the patient. I believe also, that in all such cases the chief seat of the disease is in the deeper structures of the ear.

The *fibrous* laminæ of the membrana tympani are subject to acute and chronic inflammation, to relaxation and rigidity, to calcareous deposits in their substance, and to ulceration.

Acute inflammation of these structures generally occurs in the after periods of life, and seems to be often connected with a rheumatic or gouty diathesis. The access of the attack is generally referred to cold. It commences with a feeling of heat, throbbing, and tension within the ear; there may be also pain extending to the side of the head, and increased on motion of the jaw. On examination, the membrane presents a dull reddish hue; there is tinnitus, and the hearing is impaired. This affection is almost always accompanied by inflammation within the tympanum.

In *chronic* inflammation, the fibrous laminæ become thickened and hypertrophied, and the membrane presents a leaden appearance, often with congested vessels ramifying over its surface. The hearing is greatly impaired; which is less due, probably, to the condition of the membrana tympani, than to that of the lining of the tympanic cavity. The membrane may appear flattened, or if it retain its form and curvature, it is dense and rigid; and if the patient inflates the tympanum, while the Surgeon keeps his eye fixed on the membrane by means of the speculum, the natural yielding to the stream of air is not perceived. Pain is seldom complained of, but there is frequently a great amount of tinnitus. The treatment of both these affections is the same as for inflammation of the cavity of the tympanum. Repeated application may also be made to the surface of the membrane of a solution of the nitrate of silver (ten or twenty grains to the ounce), or of the diluted nitrate of mercury ointment. The tincture of iodine also may be cautiously applied to the inner portion of the meatus.

There is an opposite condition to which the membrana tympani is liable, and in which its fibrous layers seem to be chiefly concerned—that of *relaxation.* Patients come before us in whom the membrane has lost its natural regular form, and appears almost as if crumpled, sometimes falling in towards the promontory. In some of these cases the polish and translucency of the membrane are scarcely at all diminished; in others it is opaque and dull. This "relaxation" sometimes coexists with inflammation, at others it seems to be connected with an "atrophy" of the fibrous laminæ, which cannot always be traced to previous inflammatory action. A considerable amount of deafness is present; seldom tinnitus or pain. When the patient inflates the tympanum, the membrana tympani is put upon the stretch, and may be seen to bulge outwards in front of and behind the handle of the malleus. So long as this condition of tension lasts (provided there be not other disease), the hearing is improved; but this improvement gradually diminishes as the equilibrium of the pressure of the air within and without the tympanum is restored, and in the course of some minutes is for the most part entirely lost. A similar effect is produced by a strong attempt at *inspiration* with closed mouth and nose, which puts the membrana tympani on the stretch in the opposite direction. If no improvement is produced by these means, there is reason to suspect a diminished mobility of the stapes. In the treatment of this affection, any inflammatory action that may be present should be first relieved; if the deafness continue after this is done, or if no inflammation exist, tonic remedies may be employed, and a weak solution of the nitrate of silver, or of the chloride of zinc, applied to the surface of the membrane by a camel's-hair brush, or on cotton-wool, once or twice a week. If there be any truth in the theory that the cotton-wool in cases of perforation acts by giving support to the ossicula, it should perhaps be beneficial also in some of these cases. They are very difficult effectually to relieve.

In connexion with this state of the membrana tympani, a morbid condition may be referred to, which is sometimes found after death, though its diagnosis during life is doubtful: atrophy or degeneration of the tensor tympani muscle. Probably it plays a part in some cases of deafness, and may be denoted by a want of due tension in the membrane.

Calcareous deposits are frequently seen in the membrana tympani; they present chiefly two forms: either that of a small crescentic layer, evidently taking the course of the circular fibres; or that of an irregularly radiating mass, which has its seat amid the radiate fibres. These deposits are generally met with in cases of long-standing inflammatory disease, and then deafness is present; but they do not seem to be themselves any considerable impediments to hearing, since they are also seen in patients whose hearing power is scarcely diminished, and in whom the membrane itself appears to be in other respects in its normal state. Sometimes the degeneration affects the entire extent of the membrane, which is thus converted into a bony mass. But in these cases there is usually also extensive disease of the tympanum. These deposits consist chiefly of phosphate of lime. They are most frequent when the membrane is perforated, and a chronic inflammation of the tympanum has existed for a long time; but they are by no means confined to the later periods of life. In all these cases, any inflammation that exists may be combated by appropriate means; for the degeneration itself no remedy is yet known.

Ulceration of the fibrous laminæ may occur, though not frequently, as a result of their continued inflammation. The dermoid layer of course partakes in the affection, and it is attended with a discharge from the meatus. It may either lead to perforation, or result merely in a thinning of the membrane, the mucous layer retaining its continuity. In the latter case the ulcerated surface appears depressed below the general plane of the membrane; it has an irregularly circular shape, and sometimes occupies a considerable extent. When the tympanum is inflated, the mucous membrane, lacking support, bulges at this spot, and may be distinctly seen to form a projecting sac. This condition seems not to be always accompanied with other disease, and is susceptible of benefit, especially if the ulceration be extending, by a weak solution of nitrate of silver cautiously applied to the surface; general treatment being at the same time adopted.

Perforation: the artificial membrana tympani. The membrana tympani may become perforated in two ways; either by disease affecting the membrane itself, and usually progressing from without inwards, by ulceration of its laminæ, or as the result of inflammation within the tympanum, causing accumulation of mucus or other morbid secretion within that cavity, which at length finds its way through the membrane into the meatus. In the latter case the aperture is smooth and even, and the remaining portion of the membrane for the most part retains its normal position; in perforation from primary ulceration of the laminæ, on the other hand, the aperture is more irregular, and its edges introverted, while the remainder of the membrane falls in towards the tympanum.

The diagnosis of perforation is generally easy. After the meatus has been cleaned out with warm water, the orifice may for the most part be very distinctly seen by the aid of the speculum. Or a peculiar pulsation (first described in this relation by Mr. Wilde) visible in the situation of the aperture, and probably due to the presence of a film or bubble of water, is very characteristic. If the Eustachian tube is not obstructed, the patient can blow air through the meatus with a prolonged whistling sound, which is perfectly diagnostic of the affection. The aperture may be of any size, from less than that of a pin's head to almost the entire extent of the membrane. When the destruction of the membrane is considerable, the remaining portion usually presents a distinct lunated edge; and if the greater part is absent, the handle of the malleus, with a narrow strip of membrane on each side, is generally to be seen, either occupying its natural position, or fallen inwards. Sometimes this portion of bone remains with no membrane attached; sometimes the head of the malleus alone is left, and forms a prominent and characteristic object near the roof of the meatus. The border of the remaining portion of the membrane may be adherent to the promontory, forming a more or less completely closed cavity; and if by this means discharge is prevented from escaping, the most serious consequences may ensue.

Perforation of the membrana tympani produces, for the most part, a certain amount of deafness, though when the aperture is small and the ear otherwise healthy, this is so slight as to be scarcely appreciable. In recent cases, the closure of the orifice, if small, is always to be sought; the occasional application of the nitrate of silver to the edges of the wound, and the subjugation of inflammatory action by appropriate means, will generally secure this result; but if the destruction of substance be considerable, or the perforation be of old standing, the treatment consists in the use of the cotton-wool, or the artificial membrana tympani. The latter appears to be, in ordinary cases, the most useful and convenient application. Before having recourse to it, however, it is necessary to attend to the condition of the parts involved. Almost invariably when the membrana tympani is perforated, there exists a state of chronic irritation of the lining membrane of the tympanum, attended with either a constant or an intermittent discharge. On examination, a fœtid mass of inspissated discharge will generally be found in the meatus, itself sufficient to set up inflammation; and on syringing this away, the mucous membrane of the tympanum will be seen red, swollen, and velvety; often so thickened as to project almost to a level with the orifice in the membrane. Occasionally a polypus grows from its walls. Even in this inflamed condition, the application of the artificial membrane will often produce an immediate improvement; but its use is better deferred until a more healthy state has been induced; otherwise irritation may ensue, necessitating its discontinuance for a time, and the patient may be discouraged. The passage should be kept clean by gentle syringing, and a stimulating liniment rubbed around the ear. This will often procure a diminution, though not a complete cessation, of the discharge. Or recourse may be had to mild counter-irritation over the mastoid process, and to astringent lotions, one of the most useful of which is the chloride of zinc (two grains to the ounce of water). Whatever lotions are applied should be used warm. Sometimes the discharge accumulates behind the remaining portion of the membrane, and is not easily removed. This adds greatly to the difficulty of the case, especially since the syringing must be left, in part, to the patient or his friends. Much depends upon the skill with which that simple operation is performed. In every case, however, the entire removal of the tendency to abnormal secretion is, as with all mucous membranes, a tedious task; but fortunately the introduction of the artificial membrane need not be delayed until this is accomplished, for it has itself a great influence, as soon as the extreme irritability of the mucous membrane of the tympanum has been relieved, in restoring it to a healthy state.

The artificial membrana tympani consists of a thin circular plate of vulcanised india-rubber, to which a silver wire is attached obliquely, as a handle. The mode of introducing it is thus described by its inventor. "After accurately noting the size of the inner extremity of the meatus to which the natural membrane was attached, the operator should proceed to cut the artificial membrane as nearly of the size and shape of the natural one as possible, taking care at the same time to keep the margin quite smooth and regular. The patient should then be placed with the head inclined to the opposite shoulder, while a strong light is thrown into the meatus, which, if liable to discharge, should have been previously syringed. The operator will next take the artificial membrane, and having moistened it with warm water, pass it, by means of the silver wire, gently inwards, until it has reached what he considers the natural position. This he will ascertain by the occurrence of a faint bubbling sound caused by the escape of the slightly compressed air beyond it; he will also feel a slight obstruction offered to its further passage by the remnant of the natural membrane. Should any attempt be made to pass the artificial membrane beyond this point, the patient will complain of pain, which up till then had not been felt. The most certain test, however, of the proper placing of the artificial membrane is the sensation of the patient, who discovers by the sound of his own voice, or that of the Surgeon, or by the movement of his tongue and lips, that his hearing has been suddenly improved." It is advisable, when there remains only a very narrow ring of the natural membrane, to cut the artificial one a little larger, so that its edges may turn slightly backwards when it is introduced. I have, however, sometimes found that a portion of membrane cut to the shape of the aperture, but a little larger in size, and applied directly to the ruptured spot, has answered better than when the whole surface has been covered. It may be necessary to bend or to shorten the silver wire, to enable it to lie completely, and without pressure on any part, in the meatus. At first the artificial membrane should be worn only for an hour or two, or even a shorter time, daily, and should be discontinued for a time if any irritation arise. It should always be removed on retiring to rest. If other disease be present, as of the nervous apparatus, ossicula, &c., the restoration of the hearing, of course, is not effected. But in the great majority of cases the most gratifying results follow from this simple and ingenious plan. The patient, with a little practice, learns to apply the artificial membrane himself with perfect ease, and often obtains a power of hearing that is hardly less than perfect. Often, too, it happens that the function of the organ, thus assisted, becomes so greatly improved, that after the artificial membrane has been worn for a time, it can be almost dispensed with.

If the moistened cotton-wool, first brought into general use by Mr. Yearsley, be preferred, it may be introduced either by a suitable pair of forceps, or by means of a narrow tube through which a thread attached to the cotton-wool is passed. It should be changed daily.

IV. Affections of the Eustachian Tube.

The ordinary condition of the Eustachian tube appears to be that of closure by the apposition of its walls, which thus act the part, as described by Mr. Wharton Jones, of a "weak valve." It is opened by the muscles of the palate and pharynx during the act of swallowing, and probably at all times, when in a healthy state, permits the gradual escape from the tympanum of fluids as well as of air. That it is not permanently open is shown by the effects of inflating the tympanum with closed mouth and nostrils, the feeling of distension within the ear produced by which only gradually subsides, unless the act of swallowing be performed, when it disappears at once. If this experiment be made by a healthy person while the Surgeon keeps his eye fixed upon the membrana tympani, that membrane may be seen to yield slightly to the pressure of the air, assuming a less concave position, which is retained for a time, even while the natural respiration is carried on. If the act of swallowing be now performed, the membrane may be seen to fall back at once to its normal position. Similar effects are said to be experienced during descent in a diving-bell. In addition to these facts, certain symptoms which attend *an open condition of the Eustachian tube*, first described by Dr. Jago of Truro, give evidence in the same direction. This affection is attended with a buzzing noise, and an unnaturally vivid hearing of all sounds which have their origin in the patient's own mouth, throat, or stomach, to such an extent as greatly to interfere with the hearing of external sounds.

There is at the same time a feeling of discomfort in the throat, which the patient endeavours to relieve by repeated acts of swallowing. The cause of this condition appears to be some state of the throat, but of what character is not clear; perhaps some irritation keeping the muscles attached to the Eustachian tube in a state of spasmodic action. The symptoms occur most frequently during catarrhal affections. For the most part they are intermittent, the restoration of the natural apposition of the walls of the tube removing them at once.

Much more frequent and more serious is the opposite affection, *obstruction of the Eustachian tube.* This condition may be due to various causes; thickening of the mucous membrane of the fauces or tympanum, or relaxation of the fauces, appear to be the most frequent. Stricture of the osseous walls of the tube occurs sometimes, though rarely; firm membranous adhesions are occasionally found completely closing it, and perhaps accumulations of mucus may have a similar effect. This, however, appears doubtful. I have found mucus occupying the Eustachian tubes, on dissection of the petrous bones, in a case in which the hearing was particularly observed to be quite perfect up to the latest period before death at which it could be tested, and none of the parts of the ear betrayed any of the effects produced by the closure of the tubes. It is, however, of course doubtful how long the mucus had been present. On the other hand, a thickened condition of the mucous membrane, both of the orifice and of the course of the Eustachian tubes, rendering them almost, if not entirely, impervious, is very frequently met with on dissection.

It is very questionable whether enlargement of the tonsils can be reckoned among the causes of obstruction of these tubes. Both anatomy and observation of disease contradict the supposition. In reference, therefore, to the question of the removal of these glands in cases of deafness dependent on the condition of the throat, there seems to be no reason for departing from the rule which has been laid down by various writers, that if their removal is desirable on general grounds, that is, if they are interfering with respiration and injuring the health, they should be excised, and not otherwise; unless, perhaps, in cases in which other means have failed, when the chance of benefit to the hearing may be weighed against that of injury to the patient from their loss. The slight loss of blood attending their excision may perhaps have a beneficial influence.

The diagnosis of obstruction of the Eustachian tube may be made by inspection of the membrana tympani, and by the use of the otoscope. This instrument is a flexible tube, one end of which is to be inserted into the ear of the Surgeon, and the other into that of the patient, while the latter, closing the mouth and nostrils, either makes a forcible expiration or performs the act of swallowing. If the Eustachian tube be pervious, the air will almost always be heard (after some practice) to pass into the ear during one or other of these operations. The sound that results when the organ is in its normal state is a peculiar *thud*, somewhat like the striking of a bullet against a target heard at a great distance, or like the blowing suddenly into a small bag of silver paper. When disease is present this sound may be variously modified; a creaking or whistling may be heard if the Eustachian tube be narrowed by thickening of its lining membrane; a "gurgling" indicates the presence of mucus or other fluid within the tube or tympanum. It is seldom the case that if the Eustachian tube be pervious no sound is audible, when the patient has learnt rightly to make the experiment; and if neither any sound can be heard nor any movement of the membrana tympani is seen during the actions above described, and the other symptoms agree, obstruction of the tube may be confidently inferred. But the appearance of the membrana tympani also, in these cases, is very characteristic, and might itself often suffice to reveal to an experienced eye the nature of the affection. Whether it be due to absorption of the air within the tympanum, when it is not freely renewed, or to any other cause, the membrana tympani always, when the Eustachian tube is permanently closed, becomes more concave than natural, as if drawn or pressed in towards the cavity of the tympanum. It becomes at the same time of a dull colour, and frequently somewhat opaque, the bright spot on its surface being indistinct and diffused. This condition of the membrane may be distinguished from the results of inflammation by the more decided concavity, without irregularity, and the absence of congestion or thickening.

The history also is characteristic of the disease. The deafness has for the most part arisen gradually, without any considerable amount of pain, and after repeated attacks of cold or sore throat. Often the hearing will have been suddenly restored at various periods after a loud crack or report in the ear, having been gradually lost again.

Obstruction of the Eustachian tube from thickening of the mucous membrane of the fauces. This affection is more frequent before than after middle age (the deafness of advancing years being more connected with morbid conditions of the tympanum); and it is especially common in scrofulous or otherwise unhealthy children. The appearance of these latter patients very often at once betrays the nature of the malady. There is a fulness about the back part of the jaw, and, especially when the tonsils are also enlarged, they have a peculiar expression of countenance, arising from the mouth being kept slightly open to aid in respiration. They are also apt to snore when asleep. The deafness in these cases is considerable, the patient requiring to be spoken to in a distinct voice within a yard or two. A "stuffing" in the ears, and more or less tinnitus, are generally complained of. The mucous membrane of the fauces is red and tumid. The treatment indicated is to restore the health, and to reduce the thickened membrane of the throat by local astringents. Among the latter the nitrate of silver, either in stick or solution, seems the most efficacious. It should be applied to the immediate neighbourhood of the orifice of the Eustachian tube, which may be accomplished either by means of a jointed caustic-holder, or by the aid of a small portion of sponge fixed on a curved piece of whalebone. In some recent cases, however, this seems to produce great irritation, and milder measures will suffice. A strong solution of tannin in spirits of wine may be applied once or twice a day. Sometimes a leech or two applied beneath the ears, or, by means of a tube, to the nasal mucous membrane on the affected side, or in both these situations at once, are desirable at the commencement of the treatment. Stimulating and astringent gargles may also be used, or inhalation of steam impregnated with the vapour of iodine, guaiacum, &c. In all cases of deafness connected with affections of the throat it seems a useful practice to draw cold water into the pharynx through the nostrils. This may easily be done during washing, and the act of gargling may be thus performed much more efficiently for the desired purpose than by means of liquids taken into the mouth. Frictions around the throat, either with salt and water or with stimulating liniments which may contain salts of iodine, will of course be recommended, together with ample exercise in the open air, and cold or tepid sponging. It is possible that the occasional use of the Turkish bath would expedite the cure. Tonics are often indicated, especially in children; and in their case I have thought iron in the form of the sesqui-oxide very beneficial. Great perseverance is often necessary in the treatment, but it is almost always successful. The Eustachian tube may also be obstructed by thickening of the membrane lining its tympanic orifice, as a result of chronic inflammation within the tympanum.

Relaxation of the mucous membrane of the fauces will also produce closure of the Eustachian tubes. This condition is different from that of thickening, and occurs in a different class of patients. It is met with only in adults; chiefly in persons in weak health and suffering under general relaxation of the system. Those who smoke to excess are especially liable to deafness from this cause. The lining membrane of the throat is pale and mottled, the uvula is elongated. The membrana tympani presents the characteristic dull and concave appearance. General bracing and tonic measures, with stimulating and astringent applications to the fauces and the orifices of the tubes, and the abandonment of any practices injurious to health, will generally effect a cure. In all this class of cases a temporary improvement in the hearing, sometimes amounting to several inches as tested by the watch, is produced by forcing air into the tympanum; and the patient may be advised, as soon as the power of doing this is obtained, to make a practice of effecting it two or three times a day.

The Eustachian tube may also be obstructed by stricture of its bony walls. Two cases are reported by Mr. Toynbee. The same effect may be produced by effusion of fibrine uniting its surfaces by firmly organised tissue. In such cases as these the chief point would be to make an accurate diagnosis, and to avoid subjecting the patient to useless treatment. Possibly the exploration of the canal by a sound of catgut, or of ivory the point of which has been steeped in acid, might be useful for this purpose.

Among the rarer causes of obstruction of these tubes may be mentioned, on the authority of Mr. Wilde, foreign bodies; "the most remarkable case on record is that in which an ear of barley was discovered after death projecting from its guttural orifice." The same author also mentions that he has seen deafness induced by a large fleshy nasal polypus, which passed down into the pharynx.

In cases in which the obstruction of the Eustachian tube will not yield to ordinary remedial measures, recourse must be had to operative proceedings. Two methods present themselves, in which the relief of the deafness may be attempted: the passage of the Eustachian catheter, and puncturing the membrana tympani.

The Eustachian catheter. This instrument, having been first warmed and oiled, should be passed very gently but pretty rapidly along the floor of the nostril until it reaches the pharynx. At this point either of two methods may be adopted for conveying its point into the opening of the tube. It may be carried on, its point still turned downwards, until it reaches the posterior wall of the pharynx, and then it may be drawn slightly forwards, being gently rotated at the same time outwards and upwards. In doing this it will for the most part easily slip into the trumpet-shaped orifice of the tube, and may be felt to be embraced by its walls. Or when the point of the catheter has arrived at the posterior nares, the instrument may be gently rotated outwards and slightly upwards, and carried on into the pharynx. In this way it may be passed directly into the Eustachian tube. The former plan, however, is the easier; and in the latter it is necessary to guard against entangling the point of the catheter in a lacuna which lies directly in its route. Whichever plan is adopted, the instrument may be judged to be rightly placed if it gives no pain, is pretty firmly fixed, and offers no impediment to the acts of swallowing or speaking. No bleeding should follow its use. Air may now be passed into the tympanum, either by a syringe or by means of a flexible tube, provided at one end with a mouthpiece, at the other with a small pipe fitting into the end of the catheter. The otoscope being now placed, one end in the ear of the Surgeon, and the other in that of the patient, the air, if it can be forced through the Eustachian tube, may be heard to pass into the tympanum and strike on the membrana tympani. By this means a temporary relief from deafness due to closure of this canal may sometimes be given. And besides the cases of otherwise irremediable obstruction, the catheter may be had recourse to in those instances of thickened mucous membrane, in which an immediate restoration of the hearing power even for a short period is of importance to the patient; the necessary means for a permanent removal of the diseased condition being at the same time perseveringly employed. Formerly a band round the head to fix the catheter, and an air-press, by means of which hot air or medicated vapours were forced into the tympanum through the Eustachian tube, were much employed. But it seems the almost unanimous experience of English Surgeons, that no results are attainable by that practice (which is also not wholly free from danger) that are not equally to be gained in other ways. It is certain also that in some cases, in which debility or nervous irritability is present, the repeated introduction of the catheter is productive of great aggravation of the deafness. The application of steam or of the vapours of iodine, chloroform, acetic ether, &c. to the throat or to the tympanum, when the Eustachian tube is pervious is perfectly easy, and it is a practice which may be employed in cases of thickening either of the faucial or tympanic mucous membrane. From five to twenty drops of a mixture of equal parts of acetic ether and tincture of iodine, for example, may be placed in any simple inhaler—a china teapot is a very efficient one—with about a quarter of a pint of hot water, and the vapour being drawn into the throat is to be blown gently into the tympanum (the mouth and nostrils being closed). An agreeable sensation of warmth is felt within the ear. The inflation may be repeated from six to ten times; the act of swallowing, to restore the normal equilibrium of the air, being performed previously to each inhalation. This should be done in the evening, and the throat gargled afterwards with cold water or a stimulating gargle.

Fluids may be injected into the tympanum through the Eustachian catheter. The cavity may be washed out with warm water, or medicated solutions applied to it. For this purpose an elastic syringe, especially the one constructed for an eye douche, which is furnished with a nozzle attached to an Indian-rubber tube that may easily be made to fit into the catheter, is very convenient.

Puncturing the membrana tympani. This is a truly useful operation, which, like some others, has suffered neglect through having been practised without discrimination. It is applicable in two classes of cases: first, in incurable obstruction of the Eustachian tube, the other parts of the organ being, so far as we can judge, in a tolerably normal state; and secondly, in cases in which accumulation of pus or mucus within the tympanum (which cannot find exit through the Eustachian tube owing to an inflamed condition of its walls) produces severe constitutional disturbance, or threatens ulceration of the membrane. There is a third form of disease in which there is some evidence of its having been occasionally useful, though the reason is not perfectly clear, viz. a condition of chronic inflammation within the tympanum, which has given rise to great thickening and rigidity of the membrana tympani. The operation requires caution, since two cases have been reported in which death occurred apparently in consequence of its performance.* Various methods have been resorted to for producing an opening which should not heal. A trocar, a minute trephine armed with a spiral wire to hold the membrane, invented by Fabrizzi, and a variety of knives, have been employed for the purpose; a sharp steel probe of triangular form seems, however, to answer every purpose. Whatever instrument is used, it should be introduced into the meatus through the speculum, with a good light falling on the membrane, which should be punctured in its inferior portion, either in front of or behind the termination of the handle of the malleus. A small amount of bleeding follows the incision; and if the case be a favourable one, an immediate improvement of hearing occurs. If it be desired to maintain a permanent aperture, a small portion of the membrane should be excised, or a triangular flap turned down, and the edges of the wound touched every second or third day with the nitrate of silver, or a probe may be frequently passed through it.*

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* Dr. Butcher of Dublin, in the year 1846. See Wilde's *Aural Surgery*, p. 297.

V. Affections of the Tympanum and Mastoid Cells.

The chief diseases to which the tympanum is liable are inflammation either of its mucous membrane or osseous walls; and the results of such inflammation, in the form of effusions or adhesions, rigidity of its lining membrane, deposits within its cavity or that of the mastoid cells, and ankylosis either of the ossicula to each other or of the base of the stapes to the fenestra ovalis.

Acute inflammation of the mucous membrane of the tympanum. This affection may exist in very various forms, from that of a slight degree of pain in the ear and deafness, rapidly subsiding, to that of a most severe and dangerous disease. It may occur in apparently healthy persons, and is then generally attributed to cold; it often accompanies an attack of catarrh. The mildest forms, which might perhaps be distinguished under the name of congestion, are characterised by an aching pain felt deeply within the ear, and for the most part by noises of a buzzing character; the hearing is impaired, but less in first than in subsequent attacks. The membrana tympani may be found on inspection slightly vascular, and either retaining its transparency, or dull; the meatus is healthy. Inflation of the tympanum is rather painful; the air enters naturally, or with a slight creaking sound. This affection becomes of serious consequence by recurrence; for though the attacks may soon subside, a repetition of them seems to be a frequent cause of confirmed deafness, probably by producing thickening and rigidity of the delicate mucous lining of the tympanum. The object to be aimed at in the treatment, is to subdue entirely the immediate symptoms, and to guard against a recurrence of the attacks. The former of these objects may be attained by simple antiphlogistic treatment: a leech or two below the meatus, a stimulating liniment, or a small portion of blistering-paper worn nightly on the mastoid process for a short time. Two or three drops of warm oil may be poured into the meatus night and morning. Habitual cold sponging and friction, especially around the ears, should be recommended to patients liable to this affection; and care should be taken to keep the throat in a healthy state. It is desirable to pay especial attention to preventive measures in all these cases, since they present to us one of the most common and most baffling forms of deafness in the very process of its formation. It would probably be a useful plan, if such patients inflated the tympanum with warm vapour every evening for some days after an attack; and neither patient nor Surgeon should be content unless the full normal hearing power be regained. It is very seldom that persons suffering under deafness care to continue treatment until hearing is complete, since a certain imperfection occasions no inconvenience; but such cases as these might well form an exception to the rule.

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* Before quitting the subject of the Eustachian tube, I cannot but remark that the admirable invention of the laryngoscope, affording the Surgeon a perfect view of this region of the throat, promises us great aid in the diagnosis of the affections connected therewith. It is, however, due to Mr. Wilde to observe that he has long since made use of a mirror to explore the posterior portion of the throat. See his *Aural Surgery*, p. 365.

The severer forms of acute inflammation of the mucous membrane of the tympanum are attended with intense pain, of a throbbing, darting, or bursting character, extending over the side of the head, often in the course of the nerves, and aggravated by swallowing or any other motions of the throat. There are loud and distressing noises, and the hearing is always greatly impaired; much fever too is present, and delirium often supervenes. These symptoms may either commence suddenly, in which case they generally follow exposure to cold or draught, or injudicious bathing; or they may gradually increase for two or three days, or the acute attack may supervene upon a state of chronic inflammation. On examination by the speculum, the meatus is generally found in a normal state, though it may be tender and tumid; the membrana tympani is sometimes actively congested and of a bright pink colour, at others it is only slightly reddened, dull, and mottled; and the vascular and swollen mucous membrane may be discerned through its semi-transparent laminæ. The throat is almost always actively inflamed. The act of inflating the tympanum, or of swallowing with closed mouth and nose, is acutely painful; if air enters the tympanum, the sounds are a gurgling or a prolonged creaking. There is often great tenderness over the mastoid process and immediately in front of the tragus. The treatment is that which is indicated by the pathology of the disease. In the most severe cases venesection is recommended by some authors, or cupping behind the ears. Leeches freely applied around the ear, and at the same time, perhaps, to the nasal mucous membrane, give great relief; and these may be repeated if the severity of the symptoms does not abate. Fomentations, steaming, and poultices, with all of which sedatives may be combined, and which the feelings of the patient demand to be used very hot, may be constantly applied; while aperient and cooling medicines, and morphia, or morphia combined with hyoscyamus, &c., in full doses, to procure sleep, may be administered. Some cases will improve rapidly under remedies of this kind: in others the symptoms are more obstinate, and all authors unite in recommending the administration of mercury in the form of calomel and opium; a point of practice on which I can offer no opinion, not knowing of any evidence by which the comparative progress of the disease, when these remedies are given or withheld, may be tested.

After a few days the severity of the pain generally diminishes, and in the most favourable cases the disease terminates either in resolution, or in discharge of mucus or of pus through the Eustachian tube. In the latter case, the passage of the matter into the pharynx is often distinctly perceived by the patient, and may sometimes be seen by the Surgeon. When either of these events occurs —the resolution of the inflammation, or the discharge of matter by the Eustachian tube—the symptoms gradually subside. In time the organ may perfectly recover its normal appearance and function, though it is generally several months before the restoration is complete. Continued stimulation around the ear, and inflation of the tympanum with steam containing the vapours of iodine, acetic ether, &c. may perhaps expedite this process.

In another class of cases, the matter discharges itself through the membrana tympani, doubtless because the thickening of the mucous membrane blocks up the Eustachian tube. This also may result in perfect restoration. The meatus should be kept clean by gentle syringing with warm water, which, without injuring the ruptured membrane, will avert any ill effects that might result from the irritation of the decomposing discharge upon its structures. Th stream of water may be directed against the wall of the meatus so as not to fall with any force on the inflamed portion of the organ. Mild counter-irritation may be perseveringly maintained, and tonics with iodide of potassium administered, the general and local hygiene being also assiduously attended to.

A case is related by Triquet of acute inflammation within the tympanum arising upon the disappearance of an eczematous affection of the skin. A blister was applied to the nape of the neck, and the blistered surface became the seat of a similar eruption, on the access of which the aural disease subsided. Acute inflammation of the tympanum may run on to caries of the bone, and secondary intracranial disease; but such effects are far more frequent in the chronic form of the disease. Paralysis of the portio dura nerve may also accompany it; but this complication does not generally require special treatment. When it remains after the aural inflammation is cured, galvanism is said to have been found useful.

A peculiar form of inflammation of the tympanum accompanies various febrile diseases, especially the zymotic diseases of childhood. In scarlatina it is especially frequent, but it occurs also in measles, and sometimes in hooping-cough. I should suspect that it was common in croup, since in two fatal cases of that disease, which I examined, it was present in both. The tympanum becomes filled with pus or puriform mucus; its mucous membrane thick, red, and velvety, often so swollen as almost to fill the cavity, and it easily peels off from the bone; presenting in all these respects a marked contrast to its properties in health, when it is so thin and delicate as scarcely to be recognisable, and adheres with unusual firmness to the osseous walls of the cavity, to which it serves as a periosteum. The mastoid cells generally participate in the disease, and are also found full of fluid.

One peculiarity of this class of affections is, that they are apt to excite no attention. It is seldom that any indication, at least any that would be observed by a person not on the watch for it, is given of the inflammatory action within the ear; and the first symptom that is noticed is a discharge from the meatus, which occurs, for the most part, only after irreparable injury has been done. Should it not, therefore, be a rule with the medical attendants of children suffering from any of this class of diseases to prove the absence of this affection of the tympanum, by examining the membrana tympani with the speculum and lamp, instead of assuming that it is not present, unless palpable symptoms force it upon their notice? Such an examination, it seems to me, should be held imperative, at least in every case in which anomalous symptoms arise, and the patient's general condition seems worse than the progress of the disease might have given reason for expecting. The appearance presented by the membrana tympani is quite sufficient to determine the presence, the nature, and even the stage of the disease. The inflammatory action commencing *within* the tympanum, the external layers of the membrana tympani retain their transparency, and permit either the opaque fluid or the thickened and congested mucous lamina of the membrane itself to be clearly distinguished through them. This is an appearance which, once seen, can hardly be mistaken. In the early stage of the affection the membrane presents an increased concavity, owing, I presume, to closure, by thickening of its lining, of the Eustachian tube; and there is often no other alteration in its appearance, except a bright pink colour seen *through* it. In the later stages the membrana tympani grows flat, it is dull and sodden in its hue, and at length manifestly bulges outwards before the accumulated secretion. The treatment would be guided by circumstances. In the slighter cases it might be possible, by antiphlogistic means, to subdue or check the local inflammatory action. In patients prostrate from severe scarlatina, or the like, it might be hopeless to attempt this. But in these more formidable cases, might not excellent results be expected from the evacuation of the matter by perforation of the membrana tympani? If, as in a case mentioned by Abercrombie, a discharge of matter from the ear restored to health a woman who had lost consciousness, might it not preserve from death a child depressed already to the lowest point by the poison of scarlatina? Might not such a patient's tenderer brain and feebler powers succumb entirely to a source of irritation which could produce symptoms so grave in an adult unaffected by other disease? I do not hesitate to avow my conviction, that by a prompt attention to the condition of the ear, and prompt evacuation of pus from the tympanum when evidence was given of its presence there, the balance might often be turned between life and death, and the mortality from scarlet fever and the allied disorders notably diminished. What else does the following report indicate? A girl, aged eight, died in convulsions after scarlatina. No important disease was found, but the tympanum on each side was full of purulent matter, the membranæ tympani slightly bulging. It is true the urine was albuminous; but is it not so in the vast majority of cases of scarlet fever that recover? There was no decided disease in the kidneys. A case is reported by Mr. Harvey,* in which the evacuation of matter from the tympanum in a case of acute scarlatina seemed to be attended with the best results.

A very large proportion of the cases of perforation of the membrana tympani with chronic inflammation of the mucous membrane of the tympanum, and constantly recurring discharge, which are so frequently met with, originate in these diseases. Their management, when in this stage, has been spoken of under the head of Perforation of the Membrana Tympani. I have met with one case, a child aged five years, who had been deaf since the measles, two years before, in whom a mild attack of scarlatina very considerably improved the hearing. The membranæ tympani in this case were normal.

Deafness often supervenes in the course of typhus or typhoid fever. In some of these cases it seems to be due to a peculiar form of inflammation of the tympanum. The cavity becomes the seat of a sanguineous effusion, which is found after death either in a fluid or coagulated state. The mucous membrane seems at the same time disorganised, and the osseous walls may be soft and infiltrated with red fluid. A considerable proportion of the cases of confirmed deafness met with after fever, are probably of this kind; but not all of them. For sometimes the tympanum is found quite healthy, and the cochlea, or vestibule, or both, contain an effusion of bloody fluid; sometimes no appreciable alteration of any part of the organ is found, though the loss of hearing has been complete.

Chronic inflammation of the mucous membrane of the tympanum. This affection occurs in various forms. It may produce an accumulation of mucus or of pus within the cavity; or may lead to the formation of bands of adhesion between its walls and the ossicula, or to a softened and thickened condition of the lining membrane, or to rigidity of the same, impairing the motions of the ossicula, and especially those of the stapes within the fenestra ovalis (membranous ankylosis).

Accumulation of pus or mucus within the tympanum is a very common affection in children, especially among those who are of a weak or strumous constitution, or who live in the unhealthy dwellings to which the poor are confined in London; and it often exists entirely unsuspected. So frequently is it found, indeed, in young children after death, that it seems to have given rise to the opinion that the tympanum during the first period of life is naturally filled with mucus, and that children only begin to gain the faculty of hearing about the third month. I have convinced myself, however, by repeated dissections, that the tympanic cavity is, in the healthy state, quite free from mucus, and that the membrane lining it is thin and delicate, at the very earliest periods. But in a large number of children, especially those suffering from other affections of the mucous membranes, the lining membrane of the tympanum is thick, red, and soft, and the cavity is filled with mucus, often of a purulent character; the Eustachian tube, by reason of its thickened lining, being impervious to the fluid. The condition, in short, precisely resembles that which occurs in scarlatina, except that it is less intense and comes on less rapidly; and the membrana tympani exhibits, on inspection, a similar appearance. I have so frequently found this state of the tympanum, in children, associated with convulsions or other symptoms of cerebral irritation, that I believe it stands to them in the relation of a cause. And if the pressure of a tooth upon the gum may so act upon the delicate nervous system of a child as to cause convulsive seizures, surely it is not improbable that the pressure of a mass of thick mucus, unable to escape from the tympanum, and probably being constantly increased in quantity even through its own irritation, might have the same effect. The intimate relation of the middle ear to the brain, and the close sympathy that exists between them, is proved by many well-known facts. Even a stream of cold water, applied without force to the membrana tympani, may cause fainting in a strong man.*

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* *The Ear in Health and Disease*, p. 101.

Cases illustrative of the coexistence of convulsive disease in children with the above-described condition of the tympanum, are related in the 39th volume of the *Medico-Chirurgical Transactions*, and in the *Transactions of the Pathological Society for* 1857. Perhaps it would not be unreasonable that whenever a child has a fit, or manifests any symptoms of nervous irritation without an obviously sufficient cause, the state of the tympanum should be examined: in short that the ear should receive the same attention that is universally given to the gums. This is the more necessary because the symptoms of this morbid condition are very apt to escape observation; those which I have noticed to be most frequent are a habit of putting the hands to the ears, or rubbing them; a cry of real pain when the ears are roughly washed; pleasure taken in having the meatus gently irritated, as by the head of a pin. In these, as in all cases of cerebral irritation, the child cannot bear to be jumped or otherwise violently moved. In one instance the child had been noticed to throw himself upon the ground and roll about, apparently in play, yet so strangely as to attract particular attention. The habit of rubbing the ears seems the most constant symptom, and one to which (as in the parallel case of dental irritation) special attention should be paid. These patients are sometimes noticed to be deaf; more frequently, especially among the poor, not so. Often they are thought to be stupid or inattentive. And here I cannot refrain from observing how frequently this is the case with children who labour under incipient deafness, and how strong a claim they have upon the Surgeon to stand between them and their ill-judging guardians, and save them from the grievous wrong and injury that are too often inflicted upon them, under the idea that what is truly due to a physical infirmity results from moral fault. Too often blows are inflicted as punishment, which directly aggravate the disease. In the case of a youth who died with caries of the petrous bone and abscess in the cerebrum, and in whom the symptoms of aural disease dated from early life, his father had been in the habit of boxing his ears for "inattention."

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* Convulsions are enumerated among the causes of deaf-dumbness; but may not the connexion of events, in some of these cases, lie the other way, and disease in the tympanum have been the cause of the convulsions?

In the treatment of this class of cases, attention to the general condition of the patient seems to hold the first place, and the second may probably be given to means by which the thickening of the membrane lining the Eustachian tube might be reduced, so as to permit the exit of the fluid by that channel. The mucous membrane of the fauces is always chronicly inflamed, and is benefited by the application of the nitrate of silver. I have thought also that the application of the tincture of iodine to the neighbourhood of the ear, and the internal administration of the syrup of the iodide of iron, have acted favourably.

Accumulation of mucus in the tympanum, without perforation of the membrana tympani, is less frequent in the adult than in the child. It is met with sometimes, however, and may be diagnosed by means of the otoscope; air, when blown into the cavity, either by the patient himself or through the Eustachian catheter, enters with a peculiar gurgling sound. The membrana tympani is opaque, often more concave than usual; the hearing is impaired, though not necessarily to a great degree; there is no pain. Tinnitus may or may not be present. In these cases, the use of the catheter and air-press has been recommended. But steam or medicated vapours can be blown into the tympanum by the patient himself, if it is desired. And stimulating applications to the throat, mild counter-irritation around or behind the ears, with or without a leech occasionally, and general tonic measures, for the most part give relief.

Inflammatory thickening and hypertrophy of the mucous membrane of the tympanum is met with, for the most part, in connexion with destruction, more or less complete, of the membrana tympani, and has been spoken of under the head of perforation of that organ. Sometimes, though much more rarely, it exists while the membrana tympani is perfect, being due, in all probability, to repeated attacks of subacute inflammation, especially in a strumous, gouty, or rheumatic constitution. The membrane is red, soft, and velvety, and may be so tumid as nearly to obliterate the cavity. The membrana tympani is more or less fallen in, opaque, thickened, and with a slightly reddish hue; congested vessels may be visible on its surface. The Eustachian tube is obstructed, or air enters with a creaking sound, as if forcing its way through an almost obliterated passage. The diagnosis, however, is difficult; the prognosis not favourable. Besides the ordinary local and general measures, small doses of the bichloride or biniodide of mercury may be given, in bark, for a considerable period; or any medicines adapted to combat the rheumatic habit, if it be evidently present. Too much stress, however, cannot be laid upon the regulation of the mode of life. A careful diet, exercise, avoidance of close atmospheres or sudden variations of temperature, may at least delay the progress of the disease. For these cases, Triquet* recommends the injection into the tympanum of a weak solution of caustic potash.

Ulceration of the mucous membrane of the tympanum is seldom met with. When it does occur, it is generally in connexion with strumous or other constitutional affections of the organ, and for the most part the bone is also implicated, leading on to inflammation within the head. The treatment should be very guarded; and strong local astringents should be abstained from.

Syphilitic inflammation of the tympanum. It cannot be doubted that deafness is sometimes due to syphilitic affections of the middle ear; but these cases are rather to be distinguished by the history than by the condition of the organ.

Deposits within the tympanum. Cholesterine is sometimes found in this cavity and the mastoid cells in considerable masses; chiefly in advanced life. Another form of deposit, which occurs for the most part in the young, is probably of a tuberculous character; it is a soft caseous mass, consisting of degenerated cells and granular matter. In these latter cases there is most frequently a secondary or coincident affection of the brain. Dr. Gull* questions whether these deposits are of a strumous character, and holds that they consist simply of inspissated and degenerated pus. The coincident affection of the petrous bone seldom presents the characters of strumous infiltration, but rather those of ordinary caries. Yet cases occur in which the tubercular character of the affection can hardly be doubted; for example, where tubercle exists also in the lungs, or where, as in a case reported in vol. xxxix. of the *Medico-Chirurgical Transactions*, tubercular masses, of a similar character, exist in the tympanum and the adjacent portions of the brain. In the case of strumous deposit within the tympanum, the membrana tympani generally ulcerates, and exposes the cavity. The treatment naturally suggests itself; but it is of course doubtful whether any treatment could be of avail.

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* *Maladies de l'Oreille*, p. 427.

Membranous bands, extending between different parts of the tympanum, and connecting the ossicula to each other or to the walls of the cavity, are frequently met with after death. Respecting these I have made two observations, which appear to me to be of interest. The first is, that mere mucus in the tympanum, if exposed to the air in a dissected petrous bone, will in the course of a few days dry up into broad bands, undistinguishable by the eye from those which are so frequently met with. It is true the "bands" thus formed present no structure under the microscope, while some of the membranous adhesions, which are found already existing on dissection, have a fibrillated appearance. Yet it seems probable to me that mucus may dry up within the tympanum during life, and may thus give rise to the appearance of bands in some cases. I am induced to hold this opinion from the extreme frequency with which these membranous bands are found. Bands were present in 271 out of 1149 dissections of diseased ears made by Mr. Toynbee, and in 30 out of 94 such dissections made by myself. They occur also in cases in which there is no other appearance of inflammation, and indeed where the probability is very strong that it has never existed. I have found a very broad and distinct band in the mastoid cells of an infant four months old. It is hard to understand how real fibrinous adhesions should form in such a cavity as the tympanum without the effusion of a considerable quantity of lymph, which must involve, one would suppose, an attack of inflammation of a formidable kind. I have observed, also, that membranous bands in the tympanum do not seem to affect the hearing to an inconvenient degree, unless they also interfere with the motions of the ossicula.

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* *Guy's Hospital Reports*, vol. xxxvii.

The diagnosis of membranous bands is difficult. An irregularity and increased concavity of the membrana tympani, the Eustachian tube being pervious, may give ground for suspecting their presence, which will be rendered more probable if there be a history of previous inflammation. When they have existed for any length of time, no treatment seems likely to be useful, so far as they are concerned. Their prevention forms part of the treatment of inflammation of the tympanic mucous membrane. If any thing could improve the condition of an ear in which they are completely developed, it might perhaps be the free inflation of warm vapours into the tympanum.

Many patients come before the Surgeon with a more or less complete disorganisation of the tympanum from the effects of former inflammation, in whom the membrana tympani, though not perforated, is fallen in and lies in contact, or nearly so, with the promontory, and the soft structures are infiltrated with fibrine and converted into hard and rigid masses. In such cases, if there is no existing inflammation, it is scarcely possible to suggest any means which are likely to improve the organ, and the patient must be content to obtain such alleviation as the use of a hearing-trumpet will afford him. The power of hearing, in some of these patients, is greater than the condition of the visible portion of the ear would lead us to anticipate; and even the worst cases need not always be entirely abandoned. It is often the case that when one ear has been so injured by inflammation as to be much less sensitive than the other, the patient acquires the habit of entirely disusing it, and of relying solely upon the better organ. Thus the function of the injured ear becomes deadened and sluggish from mere lack of exercise, and it is capable of being roused by use to greatly increased sensibility. Sometimes persons who have thus suffered one ear to fall into desuetude, are unfortunate enough to meet with an accident, or suffer a disease, which destroys tho other, and then they may obtain great relief by bringing into use the latent powers of the neglected organ. By means of a hearing-trumpet, or sometimes without it, an ear long supposed useless may be brought, through persevering exercise, to play a very serviceable part. On the same ground, it should always be a rule with the Surgeon to encourage those who have sustained irreparable injury to one ear, short of total deafness, to maintain it in exercise by using it alone for a certain period every day. Those, also, by whom hearing can be performed only with difficulty through disease of both ears, should be instructed to exercise what power may remain, instead of relying on the sight alone; and their friends should be willing to aid them in this endeavour.

Rigidity of the mucous membrane of the tympanum. This is a condition which frequently occurs in advanced life, and is probably the cause, in a large proportion of cases, of the deafness that is so common at the commencement of old age. The existence of this disease has been established, and its symptoms illustrated, by the labours of Mr. Toynbee. According to that author, the impairment of hearing is due to the diminution of the natural mobility of the stapes; the rigid membrane fixing it more or less completely to the wall of the vestibule. The symptoms, therefore, are similar to those of the affection next to be mentioned, the true, or bony, *ankylosis of the stapes.* The membrane lining the tympanic cavity may become rigid, either as the result of slow inflammation, or from a process apparently of degeneration, no indications of inflammatory action having been at any time present. It becomes slightly thicker than natural, but maintains its pale colour and normal polish; the stapes can only be moved by the exertion of force, which is sometimes considerable. On inspection of the ear, the meatus is frequently found devoid of cerumen; the membrana tympani is either natural or slightly opaque; occasionally it may contain calcareous deposits. The Eustachian tube is pervious; and the air enters either with the natural sound, or, if any inflammatory thickening be present, with sounds indicative of that condition. No pain is present; but there is generally an annoying tinnitus. The diagnosis depends partly on the history of the case, partly on the peculiar character of the deafness, and partly on the absence of the symptoms of other disease within the ear, or of those which characterise "nervous deafness." The chief peculiarity of the deafness is, that the "adapting power" of the organ is more affected than the mere ability to distinguish sounds. The patient is embarrassed in general conversation, while able to hear single voices with tolerable ease. This symptom, however, may also exist in cases of nervous deafness, arising from the excitement connected with a large company; but the mode of its production is different, and in the latter cases excitement produces the same effect under all circumstances. Hearing better in a noise, as while riding in a carriage or during the beating of a drum, appears to be common to this with some other morbid conditions.

The treatment recommended by the best authority on the subject is the application of a solution of the nitrate of silver (ʒss. or ʒj. to ℥j. of water) to the outer half or two-thirds of the meatus, every third or fourth day. Or the membrana tympani may be washed with a similar solution, of a strength of six grains to the ounce. If the tinnitus is severe, or there is any congestion, leeches should be applied below the ears, and vesication may be kept up, with intermissions, over the mastoid process. Small doses of hydrargyrum cum creta, or of the bichloride or biniodide of mercury, may be given; but these should be so administered as to produce no debility, nor any painful symptom whatever. To these means might perhaps be added the persevering practice of inflating the tympanum, strongly, with warm or medicated vapours. A warm bath may be taken every week or ten days. Perhaps the Turkish bath might be still more efficacious. Warm rooms should be avoided, and ample exercise taken in the open air.

This form of disease, together with that next to be mentioned, has been ascribed to a gouty or rheumatic constitution. On this point, however, farther investigation may be needed. Dr. Garrod informs me that he does not find gouty or rheumatic patients especially liable to deafness, the ear forming in this respect a decided contrast to the eye; and Dr. Gull has submitted to examination some deposits from the tympanum supposed to contain acicular crystals of uric acid, and has found them to consist of fat.* The best-marked case of the connexion of deafness with the gouty diathesis that has come under my own observation is that of a lady, aged fifty-seven, subject to attacks of gout, and slightly deaf. On the occasion of the sudden death of her husband, an intense deafness came on in the course of a few hours, which subsided on the local manifestation of gout two or three days afterwards.

Diseases of the Ossicula.

Ankylosis of the stapes to the fenestra ovalis. This is an affection which is mentioned by early writers on the ear; but the frequency, importance, and characteristic symptoms of which have been known only since the publication of Mr. Toynbee's researches. It consists in a union, by bone, between the base of the stapes and the margin of the fenestra ovalis. This condition may exist in various forms, either that of a simple expansion of the base of the stapes, or an expansion combined with a calcareous whiteness of the bone, or with effusion of osseous matter within or around the joint. In some cases, there is found a thickening and rigidity merely of the ligaments connecting the articulating surfaces. The general symptoms are the same as those of the last-mentioned affection. How far treatment is of any effect, there is as yet no sufficient evidence to show.

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* *Guy's Hospital Reports*, 1857, p. 289.

In Canstatt's *Jahresbericht* for 1859 is an account of a paper by Voltolini on this subject. Taking into consideration the very slight amount of motion normally possessed by the stapedio-vestibular articulation, it appeared to him unlikely that the deafness which occurs in its ankylosed condition could arise from its immobility. Experimenting upon the subject, he found that vibrations were transmitted best from air to a limited surface of water, when the latter was covered by a plate, which was not solidly connected to the boundaries of the aperture. It is to the alteration in this respect, therefore, and not to loss of the motion which might be given to it by the muscles of the tympanum, that he ascribes the deafness which accompanies osseous ankylosis of the stapes. In respect to the diagnosis, he rejects the relatively greater inability to understand mixed conversation than to distinguish single sounds, and relies chiefly on the appearance of the external portions of the ear:—the meatus dry, widened, without vital reaction, and leathery; the membrana tympani parchment-like, dry, thick, opaque, sometimes with earthy deposits, and immobile. The affection occurs, too, in dry and harsh constitutions. The sound, on inflation of the Eustachian tube, is normal, or too full, and the act produces no improvement. He rejects all treatment.

In connexion with this affection, Mr. Toynbee has reported a case in which a great temporary improvement was effected by a loud shout uttered close to the ear; this improvement being ascribed by him to a loosening of the stapes within its articulation. Perhaps the following case, related by Triquet, was one of a similar nature. A man had suffered from deafness, coming on gradually for many years, without any known cause. It was attended with tinnitus. In a fit of despondency he fired a pistol into the right ear. The bullet destroyed the auricle and fractured the meatus, passing out beneath the scalp. The hearing in that ear was raised by the shock from two to twelve centimetres. Indeed, the causes which will sometimes seem to improve the hearing in cases of deafness are such as we could by no means anticipate. An elderly lady, who had been under my care for deafness attended with perforation of the membrana tympani, was seized with paraplegia. The hearing became decidedly better at the time of the attack, and continued so for some years.

Exostoses, or deposits of osseous matter, are occasionally found on the other ossicles. One case also is on record of *fracture* of the handle of the malleus. It was found in the body of a man who died in Guy's Hospital from disease quite unconnected with the ear, and is reported in the *Pathological Transactions*, vol. x. p. 236. The fracture took place just above the processus brevis, at the point where the tensor tympani ligament is attached; the fractured surface was smooth and convex, and seemed to have played on a false joint upon the body of the malleus, which was displaced inwards.

Dislocation of the ossicula is more frequent; it generally occurs between the incus and stapes, and is accompanied with caries of the bones, or other effects of inflammation. In the severer forms of inflammation of the mucous membrane of the tympanum, indeed, caries of these bones is a not unfrequent result. For the most part, when this occurs, the membrana tympani is perforated; but this is not always the case. The head of the malleus, the incus, and one crus of the stapes, have been found to be destroyed by caries, that membrane being entire.* The patient was a woman aged thirty, who died of acute peritonitis.

In cases of perforation, the incus frequently comes away in a more or less carious state; the malleus also, but less frequently; and still more rarely, the stapes may be separated from its attachments and cast off. Whether total deafness necessarily results from loss of the stapes, involving as it must do the discharge of the perilymph from the internal ear, is as yet undecided.

Diseases of the Mastoid Cells.

Besides participating, as they for the most part do, in inflammatory diseases of the tympanum, the mastoid cells are subject to affections which do not involve that cavity. They may be the seat, for example, of deposits, chiefly of cholesterine, while the tympanum is free; and inflammation leading to caries or necrosis of their osseous walls may coexist, though seldom, with a comparatively healthy state of the adjacent parts. This latter affection is more frequent in childhood than in adult life, and, whether consequent upon disease commencing in the tympanum or not, demands prompt measures to prevent extension of the mischief to the intracranial organs. The symptoms are, tenderness over the mastoid process, followed by redness and tumefaction; a discharge generally issues from the meatus, although the walls of this passage may be perfect. Sometimes an obscure fluctuation may be felt behind the ear. There is generally at this stage of the disease headache, and pain extending over the back of the head and neck; often giddiness, and other symptoms of irritation of the brain. The most essential point in the treatment is not to neglect, nor to defer too long, an incision, freely exposing the bone. This should be made in the vertical direction about half an inch behind the ear, and should extend the whole length of the mastoid process. Great relief almost invariably follows. Sometimes exit will be given to a few drops of pus, and the knife will penetrate the softened bone. Poultices should be applied, and a free discharge encouraged. Portions of dead bone may come away, or the wound may gradually heal without exfoliation. If the cerebral irritation should continue, a seton applied to the nape of the neck, or an issue in the arm, may be found useful, the utmost care being at the same time taken to insure a free exit for matter. The use of the trephine to remove a portion of the mastoid process, and to give exit to matter contained in the mastoid cells or tympanum, has been recommended. The proceeding is feasible, and might be had recourse to if other means were unavailing.

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* Triquet, from the *Gaz. des Hôp.* Jan. 1851.

VI. Affections of the Labyrinth and Auditory Nerve.

These are divisible into two classes; those in which demonstrable pathological changes are or are not present. But our knowledge on the subject, and our means of diagnosis, are both as yet very imperfect. Among the morbid conditions found within the labyrinth, the most frequent are: vascularity of the walls and membranous tubes; deficiency of the labyrinthine fluid; excess of otoconia; effusions of lymph, of red serum, or of blood, the latter being chiefly found after typhus or typhoid fever. The tympanic aperture of the cochlea has been found filled with osseous deposit. The auditory nerve is sometimes, especially in old persons who have been long deaf, atrophied, and much reduced in size; but it is doubtful whether this condition is not rather a result of prolonged disuse than a cause of deafness.

Two interesting cases are quoted by Triquet from Meniere (in his translation of Kramer); one of a girl exposed to severe cold for several hours, by having to travel in an open carriage at night, during the catamenial period. In a few hours she became completely deaf, without pain. Death soon followed. There was found, throughout the labyrinth, "a sort of plastic, reddish lymph, which appeared to be the product of an inflammation of all the membranous surfaces which line the internal ear." In another similar case, proving fatal in two months, there existed the same plastic lymph, of yellow colour, occupying the labyrinth, with a number of small gray, opaque points scattered through it, resembling commencing tubercle. In some rare instances, the bony portion of the internal ear becomes necrosed, and finds exit through the meatus externus without producing disease within the skull. In a patient of Mr. Shaw's, a boy who had suffered from scarlatina two years and a half before, almost the whole of the bony labyrinth was thus cast off, being removed by the forceps from the external meatus.* And in the case of an old man, who came under my own observation, the entire cochlea, with some of the adjacent bone, had come away.

Nervous deafness. This affection is, doubtless, frequently due to one or other of the lesions mentioned above; but there can be little doubt that cases occur, in which the hearing power is more or less completely lost, without the existence of any organic change appreciable by our present means of examination. The frequency of this affection has, probably, been often exaggerated; but when all the causes of deafness which have their seat in the conducting portions of the ear have had their full weight allowed, and all the cases in which there is reason to believe there has existed any inflammatory or degenerative action within the labyrinth are set apart, there still remains a considerable number of persons in whom there appears to be a defect of power, either of the nerve to receive, or of the brain to appreciate, sound. The characteristics of this form of deafness are, a healthy state of the ear, so far as it can be explored; an inability to hear sounds conveyed by the bones of the skull; a peculiar constitution; frequently an hereditary predisposition; for the most part, a great aggravation of the deafness, by excitement or depression of mind; and lastly, the history of the case. A careful inquiry seldom fails to elicit some circumstances or events of a depressing character, or some shock either to the system or the ear, to which the injury to the hearing power may be attributed. Tinnitus, often constant and of a very distressing character, is generally present.

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* *Transactions of the Pathological Society*, vol. vii. p. 335.

Patients suffering from deafness due to conditions of the nervous system come under two classes: those in whom the affection is seated (probably) in the labyrinth, or auditory nerve; and those in whom the deafness is accompanied by general nervous debility, and is to be referred rather to the nervous centres. Among the former cases are to be placed those in whom the deafness is suddenly produced by a loud sound (without injury to the membrana tympani), or by a fall; or follows immediately upon exposure to great cold; or comes on during mumps, without alteration in the appearance of the ear. Among the latter are the cases of deafness arising from prolonged lactation, or the operation of other debilitating causes, such as fatigue in tropical climates, excessive exertion of body or mind, over study, sorrow, want of sufficient sleep. In persons predisposed to the affection, very slight causes may apparently determine its access. In one well-marked and severe case, it supervened upon the administration of a strong purgative. This form of deafness is by no means confined to adult life; if any thing, it is more frequent in the young; and it may be met with among children at school, or subject otherwise to excess of study. Deafness has alternated with other affections as a result of worms.

Loss of hearing is sometimes a symptom of tumours pressing on the brain. In this case it seems to be generally attended with other affections of the nervous system, which a careful examination would detect.

I am of opinion that there may be a "hysterical" deafness; at least, I have met with the case of a girl who suffered greatly from the confirmed intemperance of her mother, and who was liable to very complete temporary loss of hearing. It would come on rapidly, and disappear suddenly, the hearing being good in the intervals. The inspection of the ear revealed no disease.

The treatment of nervous deafness should be guided by the nature of the affection in each particular instance. If there be reason to suspect a syphilitic taint, or if the gouty or rheumatic diathesis be well marked, and there exist signs, however obscure, of an inflammatory or irritable condition of the labyrinth or nerve—as for example, the increase of deafness, or of tinnitus, by moderate stimulants, such as a single glass of wine—a corresponding antiphlogistic and specific treatment might be had recourse to. But for the most part, if the deafness be truly seated on the inner side of the tympanum, severe measures do unmitigated harm. Repeated blistering may effect a temporary improvement, at the expense of a permanent aggravation. Electricity, so far as it has yet been tried, seems to be of no permanent value. It is not, however, hurtful, so far as I am aware, and the magneto-electric machine forms a convenient apparatus which patients may easily be taught to apply themselves, if their cases seem suitable, and they must otherwise be wholly abandoned. Whenever the affection can be traced to any debilitating cause, and it is of recent access, the removal of the cause with a general tonic hygiene may be attended with a perfect cure. Of all medicines, a combination of quinine and morphia in small doses, taken perseveringly once or twice a day, seems the most useful. Stimulating liniments around the ears, perhaps containing chloroform, if tinnitus is a prominent symptom, are at least unobjectionable; and the free use of cold water and friction may in most cases be advised. I have never known any benefit produced by strychnia. Mr. Braid, in the *Association Medical Journal* for Sept. 1855, has reported some cases of "nervous deafness" benefitted by hypnotism. The deafness caused by falls, when great in amount and unvarying, is one of the least amenable to treatment.

If hearing-trumpets are had recourse to in these cases, and they are advisable when the deafness is confirmed, care should be taken that they are such as not to try the ear, by producing a loud metallic resonance. The patient's own sensations are the best guide in selecting them, and they should not be more powerful than is absolutely necessary. A very convenient form is one that passes by a spring over the head; and in the case of women it may be almost entirely concealed by the hair.

Loss or diminution of the nervous power may, doubtless, coexist with other diseased conditions of the organ, and may aggravate the effect of inflammatory lesions of the tympanum, membrana tympani, or meatus. In these cases the symptoms would be of a mixed character, and it seems to me that this is often the case. The disappointment which sometimes attends the best-adapted measures for the relief of patients suffering under diseases of the latter class may be due partly to this cause.

A true *neuralgia* of the ear has been described, though it seems to be a rare affection, except as connected with disease of the teeth. It is strictly periodic; the ear is healthy in all respects, and the hearing power is not diminished. It demands nothing peculiar in its treatment.

For tinnitus, when it forms a prominent symptom, and rational treatment fails, various specific remedies have been proposed. Mr.

Wilde believes the tincture of arnica has been successful. Triquet reports cases cured in a few days by daily injections of the vapour of chloroform into the tympanum. Kramer affirms, that tinnitus is in all cases due to irritation of the chorda tympani, and not of the acoustic nerve; and says that the repeated injection through the Eustachian catheter of a drop or two of a solution of strychnine (one grain to the ounce of water) will generally cure it.*

Excessive sensibility to sound (or hyperacousia), and the perception of a second sound, often discordant, accompanying every tone (paracousia), are rare phenomena, except as occurring in the early stages of inflammation within the tympanum. They are, however, sometimes persistent, and occasion great annoyance. A case is quoted from Sauvage, in which a musician was compelled to give up his occupation because he continually heard a second inharmonious note with every note he played.

Among the causes of deafness, having its seat probably in the nervous structures of the ear, must be mentioned hereditary syphilis. According to Mr. Hutchinson's experience, deafness of a very extreme character is frequent among this class of persons, and in some of them, whom he has given me the opportunity of examining, there existed an almost total loss of hearing, while the condition of the parts of the ear open to examination was scarcely altered from that of health.

VII. Diseases of the Ear implicating the Brain or Lateral Sinus.

This fatal class of diseases has been long recognised, but much additional light has been recently thrown upon their pathology by the investigations of Mr. Toynbee and Dr. Gull. The former has shown that inflammation of any portion of the ear, either of the meatus, the tympanum, the mastoid cells or labyrinth, may extend to the bone, and lead to a fatal issue; and has established it also as a general rule, that disease advancing from either of these portions of the organ sets up morbid action in certain definite localities within the cranium. Thus inflammation of the meatus or mastoid cells tends to produce disease of the lateral sinus or cerebellum, except in young children, in whom the mastoid cells are very small, and are in relation rather with the cerebrum. Inflammation of the tympanum for the most part extends towards the middle cerebral lobe; and when the labyrinth is involved, which seldom happens except by extension from the tympanum, the progress of the disease takes the course of the auditory nerve towards the medulla oblongata. Other observers, while allowing the great exactness and importance of the relations thus pointed out, have held that exceptions occur, and that disease, commencing in any portion of the ear, may progress inwards by various routes.

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* For the experiments on which this view is founded, see his *Ohrenkrankheiten in den Jahren* 1851-1855.

The chief secondary diseases produced by aural inflammation are three: inflammation of the dura mater and the other membranes; abscess in the substance of the brain; and inflammation of the lateral sinus, with its effects. The two former of these affections are for the most part found together; but cases not unfrequently occur in which, while the dura mater is inflamed, the cerebral tissues exhibit scarcely any appreciable alteration; or, on the other hand, in which one or more abscesses exist within the brain, while the dura mater appears healthy. Besides these cases of demonstrable secondary disease resulting from inflammation within the ear, instances occur in which death takes place with symptoms of cerebral affection, but in which no lesion whatever is found except within the tympanum.

The early symptoms of implication of the brain are rigors, often at first resembling attacks of ague (so that they have been treated with quinine); and pain in the head, gradually becoming intolerably severe. This pain for the most part extends over the back of the neck, and it is greatly increased by motion. Delirium, impairment of consciousness, of speech, or of muscular power may ensue, and death follows, the pain generally being intense until the last. The sudden cessation of a chronic discharge from the meatus, accompanied with pain and fever, frequently marks the onset, or at least the threatening, of an internal inflammation.

The symptoms, however, are not always of this acute character. As in other forms of abscess within the brain, there may exist for a considerable period scarcely any indications of the serious mischief that has taken place. Nor do there seem to be any general symptoms by which an abscess within the cerebrum can be distinguished from one situated in the cerebellum. Treatment, in this affection, is of avail to save life only in the earliest stages. When suppuration is established within the brain, and there exists a diseased bone in its immediate vicinity acting as a constant source of irritation, it is probably vain to hope to do more than alleviate the sufferings of the patient. The first and main indication in all cases is to obtain and preserve a perfectly free exit for matter. A case is reported by Dr. Gull, in which, though it issued fatally, a decided mitigation of the symptoms followed a discharge of matter through the nose; and an indication is thus afforded of the Surgeon's chief task in every instance of this affection. Perforation of the membrana tympani if it be entire; or its incision, if by adhesion to the promontory or otherwise it act the part of a valve; or trephining of the mastoid process, might be had recourse to, if necessary, to avert the retention of pus. In some cases polypi seem to obstruct the meatus; and then their removal becomes a matter of the utmost importance. A case is related by Bonafond, in which the crushing of a polypus gave exit to a large quantity of matter, with immediate relief to the gravest cerebral symptoms.

When inflammation extends from the ear to the lateral sinus, it proves fatal by secondary disease of the lungs, which become affected with lobular pneumonia and pleurisy; pneumo-thorax also, and sloughing of the lung, frequently occur. The symptoms are rigors, with sweats, fever, pain in the head and back of the neck, followed by the stethoscopic indications of pleurisy; vomiting is often present. Tenderness and swelling may generally be found in the course of the jugular vein. On examination after death the portion of the mastoid cells, forming the floor of the lateral sinus, is carious to a greater or less extent, and that vessel contains a disorganised clot mixed with pus.

Although when these affections of the brain or lateral sinus are once established, the Surgeon is powerless to stay their course; yet many cases occur in which symptoms of the most threatening character may be entirely removed by care. In these patients either the membrana tympani has been perforated, and the mucous membrane of the tympanum inflamed, for a long time, a purulent discharge from the meatus being either constant or occurring at intervals; or, without rupture of the membrana tympani, there is a chronic inflammation of the meatus attended with discharge. During a cold, or from general ill health, or from a blow, or even without ascertainable cause, the symptoms become aggravated, perhaps the discharge suddenly ceases; pain arises in the ear, extends over the side of the head, and is greatly increased by motion; giddiness may follow, with inability to stoop; fever is sometimes, but not always, present, and there may even be delirium; or slight attacks of the kind may recur at intervals and pass off. In these cases an entire abstinence from work, or any kind of excitement, must be enjoined; and, except in the mildest forms of the disease, the patient should be confined to bed. Leeches should be freely applied around and beneath the ear, and by fomentations and poultices the external discharge, if it have ceased, should be encouraged to return. The meatus may also be syringed, very gently so as to avoid giving pain, with water as warm as it can be borne. After the leeches counter-irritation should be employed; and a seton may be worn at the back of the neck until every symptom of cerebral irritation has disappeared. Purgative and alterative medicines may be administered, according to the judgment of the Surgeon; but the latter demand caution. The injurious effect of mercury, when once suppurative action has commenced within the brain, is well known. If there be puffiness or tenderness over the mastoid process, an incision down to the bone in that region should not be omitted; and any obstruction to the escape of matter should be thoroughly removed. Under these means symptoms of a very serious aspect will often entirely disappear; but great perseverance and prolonged caution are required.

Another fatal consequence of disease of the ear is hæmorrhage. This occurs from ulceration of the coats of the adjacent vessels. Mr. Wilde relates two cases, following scarlatina, in one of which the lateral sinus was found ulcerated. One case I have seen in a man of middle age, in whom severe pain in the ear was followed by repeated attacks of bleeding from the meatus. The patient sank, apparently exhausted by loss of blood; and on examination there was found caries of the tympanic walls, causing ulceration of the coats of the carotid artery.

VIII. Malignant Disease of the Ear.

This is an affection occasionally met with, though it is not frequent. It commences in the deeply-seated parts of the organ; and a large part of the temporal bone and of the adjacent portions of the skull may be destroyed before life succumbs. The affection calls for no special remark, except that, as before observed, it is at some stages liable to be mistaken for polypus. The only case in which real difficulty would be likely to arise in the diagnosis, might be that of a polypus causing irritation of the brain by preventing the escape of matter; and here the history, and the difference of the symptoms in the two cases, could hardly fail to give the necessary guidance.

JAMES HINTON.

DISEASES OF THE NOSE.

Hypertrophy of the Skin.

THE integument of the nose, according to Kölliker, is characterised by a thin epidermis, a dense cutis with minute undeveloped papillæ and fine hairs, as well as by a close adipose tissue intimately connected with the cartilage, containing large sebaceous follicles extending into the latter, and minute sudoriparous glands. We here occasionally meet with an outgrowth, akin to elephantiasis of the scrotum, and depending on hypertrophy of the skin, of the sebaceous follicles, and of the subcutaneous connective tissue. When cut into, it has a brawny consistence, and sometimes is almost as hard as cartilage. It may extend uniformly, or form irregular excrescences, and give rise to great deformity. The swelling may enlarge in extreme cases so as to hang down to the chin, and interfere with respiration, the organ of voice and that of vision, the patient being able to see an object by one eye only, and that by shifting the position of the head or of the nasal protuberance. This hypertrophied condition is seldom met with in individuals under fifty years of age. The treatment consists in removing the outgrowth with the knife, the Surgeon keeping his finger in the nostril so as to enable him to determine the extent to which he should carry his incision, and to guard against injury of the lining membrane of the nares. The operation is indicated in the instance of tumours which are a source of inconvenience from their size and weight, and ought not to be inconsiderately resorted to, because there is always a risk of danger from serious erysipelas of the face supervening. The most favourable for removal are such as are attached by a pedicle. The after-treatment consists in the steady employment of cooling applications to the part. When cicatrisation is accomplished, it is remarkable how little disfigurement remains. In some rare instances there has been a reproduction of the growth after extirpation.

Cancer of the skin. A formidable affection from which the nose occasionally suffers is cancer, both in the form of scirrhus and of encephaloid. When the latter, it presents a fungous appearance, and is attended with repeated hæmorrhage and ichorous discharge. The chief remedy, and that not a very hopeful one, is the knife; and should notable deformity be likely to follow the operation, it will be expedient to correct it at once by autoplasty, and not to wait for the healing of the wound. Escharotics are alone admissible when the knife fails to remove the whole of the morbid tissue. Arsenious acid is one of the most efficient, made into a paste, with the addition of glycerine, which has a solvent action. This ought not to be applied before the third day after excision, and when suppuration is fairly established; advantage may possibly be gained in some instances likewise by the employment of chloride or sulphate of zinc, according to the directions given under the head of "Lupus."

The nose is sometimes attacked with epithelial cancer. This commences generally as a small wart, attended with itching. The patient is led to scratch it, and thus the part becomes excoriated and gets covered with a crust, which he picks off from time to time. Presently ulceration sets in, characterised by hardness of the base, and thickened, callous, everted edges, with vessels ramifying on their surface. In structure it is chiefly composed of cells of large size, which bear a resemblance to those of the tesselated or scaly epithelium, and which are inseminated, so to speak, in the interstices of the skin. It makes progress but slowly. It seldom assails neighbouring parts, or affects the lymphatic glands in the vicinity, or superinduces the cancerous cachexy. It is rarely met with in individuals under forty years of age. It may generally be destroyed by escharotics, such as arsenious acid, chloride of zinc, sulphate of zinc, and the like, or else extirpated by the knife. In one well-marked case, in an elderly man, I succeeded in effecting a cure by means of an arsenious paste. In another refractory case, which came under my care, the patient being 49 years of age, and the disease of fifteen years' standing, there was an oval sore about the size of a florin, the centre of which was studded with a few indurated granulations, which emitted a little ichor, and its edges thickened, indurated, and of a dusky red hue, from vessels ramifying over them. I tried excision with the knife, then chloride of zinc, next arsenious acid, and at last completed the cure by an ointment composed of equal parts of finely pulverised sulphate of zinc and cerate. I saw this man a year afterwards, and the cicatrice remained perfect.

Syphilitic ulcer. The nose is occasionally the seat of ulceration in persons affected with constitutional syphilis. These ulcers attack usually the alæ or the tip of the nose, and commence most frequently as small pimples, red, hard, and somewhat painful, which eventually suppurate and terminate in ulceration. At other times the skin covering the fibro-cartilages inflames and gives way, sometimes by cracks or fissures. The resulting ulcer has an unhealthy aspect, and an irregular, fringed margin. It emits an ichorous discharge, which, when allowed to dry, forms crusts; and it erodes, first the skin, and next, if unchecked, the fibro-cartilage. The surrounding integument presents a red blush. The treatment, which I have found most efficacious, consists in the exhibition of iodide of potassium, provided mercury has been previously administered, together with the employment of a lotion containing a grain and a half of bichloride of mercury dissolved in an ounce of water. In a case, which came under my care, where there was an ulcerated patch extending from the ala to the tip of the nose, and which was of fifteen months' standing, a cure was in a short time accomplished by the above means. The object, under such circumstances, is to keep the constitutional disease at bay, until the arrest or extinction of its manifestations.

Lupus, or *noli me tangere*, is an insidious and obstinate ulceration of the nose, or adjacent parts. In a paper of mine, published in the nineteenth volume of the *London Medical Gazette*, I referred to it as the "erosive ulcer of the derma." It attacks both sexes indiscriminately during childhood and adolescence, at the period of life when there exists the greatest predisposition to affections of the cutaneous and glandular systems.

The individuals most liable to suffer from this particular ulceration are those of a fair, occasionally rosy complexion, with light auburn air, gray or blue irides, and a delicate skin. To a superficial observer, the general health seems unaffected; but on minutely investigating the state of the different functions, more or less derangement will, in the majority of cases, be detected in those of the chylopoietic viscera. The tongue is redder than natural, especially along the margins and towards the extremity; its central portion presents a cream-coloured fur, through which the red papillæ project. The breath is more or less offensive; the evacuations from the bowels irregular and unhealthy. To these we find superadded other signs indicative of strumous dyspepsia.

From a survey of a considerable number of cases of this disease, I am led to coincide with those authors who look upon it as a symptomatic affection. It is generally dependent on some disordered condition in the functions connected with assimilation and nutrition. If indeed ever truly *localised*, it has either been preceded or accompanied during some period of its course by unequivocal marks of those errors of function to which allusion has just been made.

Dr. Macfarlane, in his *Clinical Reports*, mentions that, in Glasgow, during the years 1818 and 1819, when the working classes were exceedingly ill-fed, he had occasion to see a greater number of cases of lupus, among the district poor under his charge, than at any former or subsequent period. According to M. Rayer, it has at times been extremely prevalent among the indigent in some parts of France, particularly the sterile regions of the Haute Auvergne, from scanty and unwholesome nourishment.

The affection is seated in the dermoid texture; and, judging from the nature of the secretion emitted after ulceration is established, in the glandular body secreting that mucus, which, according to M. Breschet, becomes at a later period the *horny matter*. On attentively examining the process set up prior to the ulcerative absorption of the epidermic layers, the following phenomena will be remarked. In some point of the attenuated and delicate integument investing the nose or cheek adjoining, a minute yellowish speck appears, surrounded by a reddish halo. The point of the skin corresponding to the tiny abscess, believed to exist in the muciparous apparatus, is removed by absorption. A mode of ulceration is at length established, which is generally superficial, not extending beyond the derma; and though accompanied with preternatural redness, yet rarely with any swelling of surrounding parts. It is characterised by its ragged edges on a level with the base; by its pale, mammillary surface, whence issues that peculiar secretion, which rapidly concretes on exposure to the air into grayish-yellow crusts; and, lastly, by its being the seat of hot smarting pain, and occasional itching. The furfuraceous crusts are soon detached, and fresh ones reproduced to supply their place; the affection meanwhile creeping on with insidious certainty.

After having subsisted for some time, the original type of the disease is modified, and in some measure obscured; the surface acquires a pink glassy aspect, and loses the papillary appearance it originally presented. When situate in a part where there is much loose cellular substance, the immediately adjacent textures become indurated, condensed, and assume a dusky-red or purplish hue.

Ulcers of this kind differ extremely one from another in their degree of virulence. If the nose is primarily invaded, and particularly the inferior portion of the septum, as frequently happens, the ulceration advances by imperceptible steps, corroding and consuming every tissue, muscle, and cartilage, down to the very bone, which at times participates in the devastation. The disease, it is true, when left to itself, may wear out, and undergo a spontaneous cure; but the mutilation previously produced is often hideous and irreparable.

That this is not merely a local malady seems further ascertained from the obstinacy with which it resists topical agents. I have seen nearly every description of stimulant tried, and myself employed the most energetic caustics, but have never known any permanent benefit accrue unless measures have been conjointly taken to modify the state of the system at large. No sooner, indeed, has the effect of the escharotic subsided, than by a reflex action the sympathetic disease of the skin is again called into activity.

An opinion is entertained by some medical men, that this, the erosive species of lupus, must run a certain course or exhaust itself, ere its career can be put a stop to by any method of art. This opinion is based rather on imperfect truth than on fundamental error. When the disease is long left uncontrolled, a morbid habit is superinduced, which ordinary means fail to eradicate. But if measures be taken at an early stage to alter and amend that peculiar condition of the system upon which the ulcerative process seems to depend, or with which it is associated, we have every reason to expect that that course will be materially abridged, and much disfigurement and mutilation prevented.

Now, a chief indication is to correct the state of the digestive organs, and invigorate the system by a proper regulation of diet, residence in a pure air, with free out-door exercise and proper attention to the state of the cutaneous exhalation and alvine evacuations. Much benefit will be obtained in many cases by substituting for a too stimulating animal diet one composed of farinaceous articles and milk. The patient must abstain from the use of fermented liquors, and have occasional recourse to bathing and gentle laxatives. Various alterative, analeptic, and tonic medicines, such as mercury, arsenic, iodine, cod-liver oil, sarsaparilla, with nitric acid, steel, and quina, will each in its turn, according to circumstances, constitute valuable auxiliaries. Of these, cod-liver oil ranks high as a hygienic means in this disease; but it requires to be taken in full doses, and continued for a considerable period of time before its beneficial effects are realised.

When a visible amelioration is perceptible in the general condition of the patient, when the different functions are all properly performed, then is the most favourable time for resorting to those topical remedies which act, not as caustics, but as powerful alteratives of the organic relations of the part, among which arsenic claims the preference. Properly applied, it produces neither local mischief nor constitutional disturbance. The best form is a solution of arsenious acid, in glycerine, containing six grains to the ounce. The favourite application of Dupuytren was a powder consisting of one part of arsenious acid in ninety-nine parts of calomel. Bichloride of mercury is also beneficial, in the proportion of two or three grains to the ounce of distilled water. Mr. Syme recommends the alternate employment of sulphate of copper and red oxide of mercury.

A topical stimulant of acknowledged utility in interrupting the progress of lupus is the red-hot iron: it often exerts a most salutary effect in modifying the nature of the sore, producing healthy granulation and abiding cicatrisation. Nitric acid I have found useful among other metallic stimulants; the solution of nitrate of silver is found to do good in slight cases. The chloride of antimony, too, has been found serviceable when used as follows: let the whole extent of the affected part be touched with a pencil of spun glass imbued with the chloride: about a couple of minutes after, the pain thus produced is to be allayed by laying on compresses dipped in cold water. In this way the energetic chloride is at once transformed into an inert subchloride. This operation is to be repeated once every ten days until the sore heal. Before resorting to topical measures it is always expedient to remove the crusts by means of emollient poultices. If there be much pain and heat about the sore, cold applications ought to be employed till these subside. It is sometimes advantageous to add a narcotic solution to the cataplasm.

The stability of the cure may be inferred from the character of the cicatrix. When the new skin is soft, free from tenderness, and nearly of the natural colour, it may be considered sound; but when it remains preternaturally red and indurated, or, on the other hand, presents a delicate, membranous aspect like an arachnoid web traversed by minute tortuous blood-vessels, there is every likelihood of relapse; a distinctive feature of the disease, in point of fact, is its proneness to heal at one point and to spread at another.

There is another form of ulceration of the nose, which seems chiefly connected with the sebaceous follicles. It is described in the above paper as the *erosive ulcer of the follicles.* This frequently originates like a catarrhal affection of the Schneiderian membrane. By and by the inflammation being, as it were, concentrated in one particular point, leads to erosive ulceration, which is almost invariably associated with perforation of the cartilaginous septum. The only circumstances whereby the patient's attention is directed to the mischief going on, are a degree of tenderness and fulness in the membrane, felt more especially on exposure to cold air, and the constant reproduction of crusts on the point of lesion : after a time, from cold or other determining cause, some portion of the external surface of the nose becomes inflamed and ulcerates. One or other ala, by continuity of tissue, is commonly attacked. Small red angry-looking tubercles make their appearance, and are speedily converted into a spreading ulceration. The ulcer all along preserves the tubercular character; the apices of the tubercles are more or less concealed by dry, hard tenacious crusts. As the disease proceeds fresh tubercles are developed, and encroach more and more upon the healthy integument. The confines of the sore have a dusky-red hue. This affection is usually attended by loss of substance, and the havoc committed by it when unrestrained is often very great. The parts ordinarily destroyed are the cartilaginous septum and ala. The disease may begin externally, and spread to the lining of the nostrils secondarily: it consists, as stated by Sir A. Cooper, in ulceration of the sebaceous follicles. Hence, whenever the preëxisting irritation passes along from the internal mucous cryptæ to the external ducts, the ensuing inflammation induces occlusion of the orifices, succeeded by ulcerative absorption of the follicles. The papillæ, endowed with a higher degree of sensibility and a greater capacity for resisting the process of disorganisation, may now and then be recognised unduly developed, and forming little vascular eminences, the adjacent textures having previously disappeared. Are we to ascribe to this circumstance the extreme sensibility of the morbid surface to the impression of any stimulus?

This variety of corroding ulcer is seldom met with before puberty. It begins most frequently between the ages of fourteen and thirty; rarely after the fortieth year, although M. Alibert has adduced cases where it occurred at a later period in life. As with the former, so with the present affection; the subjects chiefly predisposed are those of a blond complexion, with light hair and irides, and undue development of the sebaceous follicles of the nose. The latter feature may be said to characterise and accompany this sort of ulcer. The patients are seldom of a robust constitution, they feel languid, and most usually manifest signs of faulty assimilation; nor do they generally display the clear and blooming complexion indicative of health and vigour.

As respects the intensity of its progress, we observe great variation. In one individual its course is so slow as to seem almost stationary, while in another it runs on with rapid strides.

In combating this form of ulcer, so obstinate and intractable in its nature, it is indispensable towards restoring a healthy action, that we should not only destroy the morbid habit of the part, but at the same time modify the organic relations of adjacent textures. This done, the lesion will spontaneously heal. Now this twofold object can be at once accomplished by employing a thin layer of chloride of zinc paste, made by triturating one part of chloride of zinc with two or three parts of gypsum, or powdered gum tragacanth, and adding a few drops of alcohol. One or two applications at most of this paste will suffice. It ought to remain in contact for at least twelve hours. So soon as the eschar is detached, the healthy sore is to be treated with water-dressing; or if there be much unevenness of surface, with narrow strips of adhesive plaster. These ought to be symmetrically disposed, and not interfered with until they drop off. Great circumspection must be observed in using this powerful remedial agent; for, injudiciously employed, it may on one hand produce a dangerous degree of erethism, on the other only irritate the sore and exasperate the disease. In slight forms of the malady resort may be had to an ointment, composed of a drachm of finely levigated sulphate of zinc incorporated with half an ounce of cerate; or to one containing biniodide of mercury. Touching the part with nitric acid, or with nitric acid holding in solution the nitrate of mercury, will occasionally bring about cicatrisation.

Although internal remedies are here of minor importance, still the permanence of cure will be confirmed by a judicious application of the hygienic and therapeutic precepts formerly laid down.

There is one symptom we are generally called to treat, as a concomitant or sequela to the ulcer, namely, a sense of tenderness or rawness of the pituitary membrane depending on chronic inflammation. It is allayed by protecting the part against external impressions, and especially that of cold, by plugging the nostrils with scraped lint, or the fleecy down of finely carded cotton-wool. Where the irritation has persisted for a period of years, and is attended with superficial ulceration of the mucous membrane, some dilute astringent lotion ought to be thrown up once or twice every day, as directed under the head of ulcers in this situation.

Several cases are detailed in the above paper, which were under my care, and which exemplify the efficacy of the chloride of zinc in eradicating the disease.

Calculous concretions, *rhinolithes*, occasionally form in the nasal cavities, and increase indefinitely by the addition of new layers, which are progressively deposited on their surface. Bartholin relates the case of a young Danish female, who, after suffering long from headache, voided from the nose several calculi, of the size and shape of a date. Clauder witnessed the case of a woman, sixty years of age, of a catarrhal constitution, where a rounded concretion, very hard, of the size of a hazel-nut, was thus evacuated. Khern, in like manner, noticed several pisiform calculi, which had escaped from the nostrils of a young person labouring under violent cephalalgia.* Numerous other cases are referred to in an elaborate memoir on the subject, by M. Demarquay, in the 8th volume of the *Archives Générales de Médecine.* These concretions are usually met with in the lower meatus. They may originate in the frontal sinus, or in the maxillary sinus, and thence pass into the nostril. They vary in size, and may attain such dimensions as to block up the nares, and cause deviation or partial destruction of the septum. They present an uneven surface, and are of a black, gray, or white aspect. They are found to consist of phosphate of lime, carbonate of lime, magnesia, and mucus. The nucleus is sometimes an extraneous body, as a cherry-stone, or portion of a tooth. The cause of their formation is, however, often obscure. Gräfe attributed their production to the influence of an arthritic dyscrasy. Chronic inflammation of the nasal fossæ and of the lachrymal gland may determine such an alteration in the secretions as to lead to calculous deposition. Certain anatomical conditions, moreover, may conduce, such as a straitening of the nares, or of the lower meatus, which may hinder the due expulsion of the proper secretion. The most frequent cause, on the whole, is the presence of a foreign body entangled in the cavity. The ordinary symptoms are dryness of the affected nostril, with a sense of dulness and weight of the same side, associated frequently with difficulty of breathing, pain of an intermittent neuralgic character referred to the nose or forehead, and inflammatory swelling of the adjacent parts, attended with copious discharge of mucus or pus from the nares. The sense of smell may be impaired or abolished. The eye may suffer sympathetically, and be suffused or bathed with tears.

The calculus may, generally, be detected by careful exploration of the cavity. On introducing a probe or dressing-forceps, the instrument will be arrested, and a peculiar dead sound emitted, characteristic of the presence of a calculus. Should the concretion be inaccessible, the practitioner may be misled, as regards diagnosis, by the symptoms manifested by patients; thus, he may conclude, that the affection is a polypous growth, in consequence of the inability to respire through one or both nostrils; or ozæna, from the fœtid and disgusting odour exhaled; or a primary affection of the bones, in consequence of the deformity of the organ, and the accompanying suppuration.

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* Cloquet, *Osphrésiologie*, p. 627.

The treatment resolves itself into the removal of the concretion or concretions from the nasal fossæ. This may be attended with difficulty when the calculi are impacted in the lower meatus, or in the upper portion of the nose. The most convenient instrument is a small pair of curved or dressing forceps. Due precaution ought to be observed while performing extraction, lest the calculus, from asperities on its surface, or from bulk, should cause laceration of the surrounding parts. In the *Gazette des Hôpitaux* for 1859, a case is mentioned of calculus of the nostril, marked by attacks of intermittent pain, mistaken at first for neuralgia, then for necrosis of the nasal bones, where the concretion was got rid of by lithotrity in four sittings, at intervals of a fortnight. The cure was followed by slight deformity of the nose.

When the extraction is completed, resort ought to be had to soothing measures to allay irritation. Should the calculus be considered to arise from any constitutional taint, as gout for example, then suitable remedial means must be prescribed to counteract its reproduction.

Occlusion and contraction of the nostrils. Infants have been born with the nostrils more or less completely obstructed by a membrane, a circumstance mentioned by Richerand;* in general, however, the occlusion depends on an extremely constricted state of the nasal apertures. This may occur at any period of life, owing to adhesion of the cartilages of the alæ of the nose to the septum, the consequence of ulceration. It is sometimes produced by adherence of the nose to the upper lip, which may be accidental, or congenital. When the occlusion is considerable, it gives rise to more or less deformity, and interferes with the free ingress or egress of air through these cavities. This is attended with embarrassment of respiration and of speech; a troublesome whizzing in the nose; impairment or abolition of the sense of smell; a change in the tone of voice; and, in certain states of weather, an uncomfortable dryness of the mucous membrane of the mouth. If, under these circumstances, it proves a source of continued distress to the patient, and dilatation cannot be procured by the introduction of tents and the like, it may be remedied by incision, in the following manner. The patient being seated, with the head resting at a suitable height against the breast of an assistant, the Surgeon carries into the nostril a narrow-bladed scalpel with the edge directed forwards, and in withdrawing it incises in the direction of the lobe of the nose, keeping clear of its fibro-cartilage; he again introduces the knife, but with the blade turned backwards, and divides the nostril as far as the base of the upper lip, without, however, implicating the lip. Should the opening of the nostril be excessively narrow, a director may be used as a guide for the knife. After the operation, a piece of lint imbued with oil may be introduced; if both nostrils have required division, it may be necessary to introduce an elastic canula to permit the passage of air. As soon as suppuration is established, it may be advisable to maintain, or further, methodical dilatation by means of a sponge-tent, in order to prevent a recurrence of the contraction.

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* *Nosographie Chirurgicale*, 4th ed. tom. ii. p. 156.

Where the nostril is completely obstructed by a membrane, in the instance of a new-born infant, M. Richerand recommends the Surgeon, without delay, to plunge a narrow scalpel or tenotome behind the lobe of the nose, and to incise the membrane from before backwards, employing afterwards means of dilatation, as in the preceding instance.

In a complicated case, where a mere trace remains of the orifice of the nostril, a tenotome is to be introduced to the posterior extremity of this trace, the back resting on the upper lip, and carried to such a depth as to reach the corresponding nasal fossa. Then, while the instrument is withdrawn, the adhesion is to be cut through, in its whole extent, from behind forwards. If no indication exists of the opening of the nostril, the adherent parts must be divided, by little and little, and with precaution. The same after-treatment is required as above laid down.

Affections of the septum present themselves under the appearance of tumours possessing different characters; some contain blood, others pus, others a gelatinous fluid, and others again have somewhat of a cartilaginous consistence. The two former have been well described by Mr. Fleming.* The bloody tumours of the septum are always the result of injury. They resemble ecchymosis in other parts of the body, and are formed generally within the first few hours from the occurrence of the accident. They usually occupy both sides of the septum, but may be confined to one; their extent and form are very variable, the mucous membrane in some cases presenting only a flattened elevation, appearing as if raised by a uniform effusion underneath, and in others being distended to a greater or less degree. There is considerable resistance in their feel, and this, combined with extreme tension and surrounding hardness, renders it difficult to ascertain the existence of fluid within. They may always be seen by gently pressing the tip of the nose and dilating the nares; their colour is of a dark purple, and they present a smooth and glossy appearance; their connexion with the septum is by a broad base, with abrupt limits. The principal symptoms are a general fulness and stuffing of the nares proportioned to the extent of the effusion. In the treatment, the chief points are the prevention of inflammation, and the promotion of the absorption of the extravasated fluid. Evacuation by incision is rarely called for. Jarjavay cites an instance of loosening of the pituitary membrane of the septum caused by effused blood after a bruise. The swelling completely misplaced the cavity of the nose on each side of the septum, and the patient could breathe only by the mouth. An incision was made into the swelling, dark liquid blood was discharged, and a breach of continuity in the septum was detected with a probe.

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* *Dublin Journal*, vol. iv. pp. 16-28.

Abscess of the septum may follow injury; but, according to Mr. Fleming, is often connected with some scrofulous taint in the constitution, or with the presence of some of the exanthemata, as variola, measles, scarlatina. It often occurs where there is a wound of the integument, and that wound situate near the lower extremity of the nasal bones. The integument of the nose becomes œdematous, and tender on pressure. The pituitary membrane is inflamed throughout, and the portion covering the septum is uniformly turgid. The secretion of mucus is suppressed, and there is generally some febrile disturbance. Presently, matter is formed under the mucous membrane, forming a prominent swelling in either or both nostrils, and a corresponding obstruction. The pain spreads along the mucous membrane to the frontal sinuses and lachrymal passages; the patient accordingly suffers from headache and a flow of tears. The affection may also spread downwards, causing swelling of the upper lip and lower margin of the septum. The tumour is red, shining, tender on pressure, and conveys a distinct feeling of fluctuation. The base is extensive, and there is usually communication with both sides through the septum. The indications of treatment here are to prevent, if possible, the formation of matter, and to lose no time, after it is formed, in giving it free vent by incision. The patient is thus exempted from a tedious ailment, and subsequent deformity through destruction of the connexions of the cartilages with the nasal bones. In making the opening, attention must be had to the thickened state of the mucous membrane, lest the orifice should close, and the fluid reaccumulate. The discharge is generally of a thin sero-purulent nature, but by and by assumes a glairy consistence. To restore the healthy condition of the mucous membrane, stimulant and astringent applications may be resorted to, such as solutions of sulphate of zinc, acetate of lead, and sulphate of copper, in the proportion of one or two grains to the ounce of distilled water; ointments containing calomel, or oxide of bismuth, will also be found useful.

There is a chronic form of abscess of the septum, spontaneous in its origin, and very insidious in its progress. The inflammatory stage is sometimes so faint as to pass unheeded, and the patient is not aware that any thing is the matter till the abscess is fully formed; and then not so much from actual pain as from uneasiness felt in the nares. In these cases the outer surface of the nose is never involved. In this form of abscess there is less redness, tension, and tenderness on pressure than in the acute form. The abscess, besides, is more extensive, and likely to occur singly on either side of the septum. It may communicate with a collection of fluid situate outside the nose, in the upper lip, for example. The matter secreted has sometimes a highly offensive smell.

The prognosis in diseases of the septum ought to be guarded. The danger is from destruction of the bones, or cartilages, or both; and this may take place long after the apparent cure of the ailment. In the majority of cases, perforation with more or less destruction of the cartilaginous septum may be anticipated, both in symptomatic and idiopathic cases. This may be effected, as Mr. Fleming states, by interstitial absorption, without ulceration of the mucous membrane, in which case the mucous membrane of one nostril adheres to the other; or ulceration may arise, and then an opening of variable extent admits of a communication between them.

An early opening of the abscess is proper in cases of this description. Benefit will be derived afterwards from pencilling the surface with a solution of nitrate of silver, containing four grains to the ounce; and also from the exhibition of mild alteratives. Too much attention cannot be given in order to prevent extension of the disease, and to obtain a cure without any abiding deformity. This affection might be confounded with a thickened or elongated condition of the mucous membrane covering the septum, but here the enlargement is more in the shape of a fold than a distinct swelling, and there is no sense of fluctuation. It might also be mistaken for polypus; but polypus seldom, if ever, arises from this portion of the Schneiderian membrane.

Tumours containing a gelatinous fluid may be got rid of by snipping away a portion of the wall, and cauterising the interior with nitrate of silver.

Cartilaginous growths are by no means common. They interfere with breathing and articulation, cause the patient to snore, and are attended with frequent headache. The above symptoms were present in the instance of a young man aged eighteen, who was recently under my care in St. Mary's Hospital. He had suffered ever since he could remember from a fulness in the right nostril. On examination, I perceived a tumour connected with the septum and floor of the nostril, and blocking up the inferior meatus. No air could consequently pass. The patient had the peculiar *frog-face* which characterises polypus. The tumour had been taken indeed for polypus, but it was found impossible to remove it with polypus-forceps. I effected a cure as follows:—I made an incision through the side of the nose, in the direction of the line which connects the nose and cheek, in order to get room, and then gouged out the growth, which was exceedingly compact in structure. I succeeded with the gouge in clearing out the lower meatus. The operation was followed the next day by oozing of blood, and some erysipelatous swelling of the nose, which yielded to cold applications. Presently the wound cicatrised nicely, and the patient recovered rapidly from his former distressing symptoms, the nostril being completely pervious.*

The septum generally deviates to the left side, hence the right nostril is proportionately more capacious than the left. It is sometimes perforated independently of any surgical operation or disease.

Hypertrophy of the pituitary membrane. It is not uncommon to see the pituitary membrane hypertrophied throughout its whole extent, and in both nostrils; frequently the thickening is limited to the portion of mucous membrane which folds back, and lies underneath the inferior spongy bone. It ought to be borne in mind that, at the border and posterior extremity of the inferior spongy bone, the membrane is naturally thick, and the thickness depends, as Kölliker points out, not on the glands alone, but upon abundant, almost cavernous, venous plexuses in its interior.†

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* *Lancet*, April 27th, 1861.

† *Manual of Human Histology*, Syd. Soc. ed. vol. ii. p. 417.

This affection sometimes follows coryza, and sometimes arises spontaneously. It causes uneasiness in breathing, especially during cold and damp weather. On looking into the nostril, there is perceived a tumefaction resembling polypus, but of a deeper red, and not pedunculated. There is a case detailed in the clinical lectures of M. Nélaton.* In each nostril was a globular, almost transparent mass, soft to the touch, not bleeding, and completely filling the nostril. The passage of air was very difficult, indeed almost entirely cut off; the voice was nasal and the nostril dry, for the patient was obliged to breathe all the time by the mouth. The case was treated by excising a portion of the turbinated bone with the scissors. In such cases benefit will be obtained by styptic and astringent injections; touching the surface with solution of diacetate of lead or nitrate of silver, together with the approved hygienic means for controlling scrofula.

Catarrhal affections of the pituitary mucous membrane are by no means uncommon. To these the term *coryza* is applied. The membrane becomes swollen, and thereby diminishes the area of the nasal cavities, which is attended with difficulty of breathing and a flow of tears. The patient experiences at the outset a feeling of dryness in the part, ere long followed by discharge of a thin acrid fluid, sense of tickling, fits of sneezing, and dull heavy pain across the forehead. Coryza frequently renewed disposes to epiphora, and to lachrymal fistula, owing to change of structure of the mucous valvule placed at the lower extremity of the nasal canal. It may occur as a symptomatic affection in polypus of the nose, in local disease of the antrum, and as a forerunner of ozæna, or of caries or necrosis of the turbinated bones, whether of a scrofulous or a syphilitic origin.

Chronic coryza, occurring in an individual labouring under a syphilitic taint, proves often most refractory. It commences like a common cold in the nose, with increased secretion of mucus; this remains for a long time clear, and of the consistence of thin starch. The flow of mucus is increased on exposure to cold, particularly night air, and by indulgence in the use of alcoholic liquors. If the patient should happen to catch cold, the discharge becomes profuse, opaque, and ropy, assuming a yellowish or greenish colour. Uneasiness is occasionally experienced within the nostrils, with a feeling of stuffing or obstruction, as if a tumour had formed within. The discharge abates at intervals, as during sleep, and then the pituitary membrane feels drier than natural, and crusts of dried mucus are to be met with below the inferior spongy bone. Individuals thus affected are frequently blowing the nose in order to clear it of the redundant secretion, and from the force employed traces of blood are not unfrequent. On minutely examining the interior of the nostrils with the aid of the speculum, figured in the margin, the mucous membrane is seen of a deeper red than natural, and sometimes eroded here and there. The affection appears to extend to the lining membrane throughout all the windings of the nasal cavities; thus by the superior meatus it is propagated to the posterior ethmoidal cells, and by the middle meatus to the anterior ethmoidal cells, as also to the maxillary and frontal sinuses. It is sometimes attended with headache, an alteration in the character of the voice, and impairment or abolition of the sense of smell.

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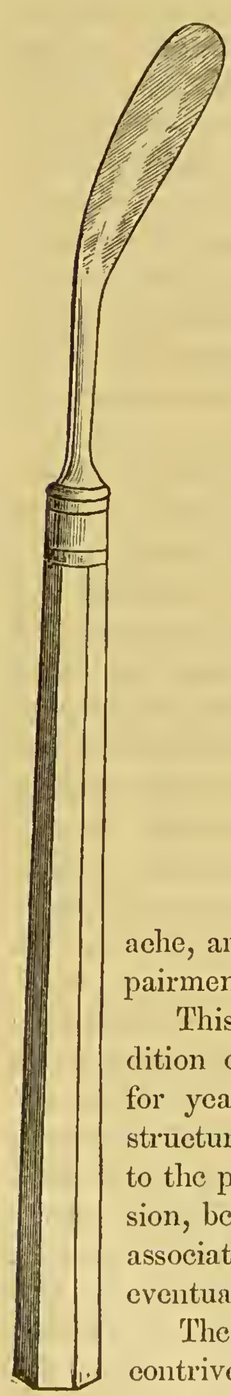
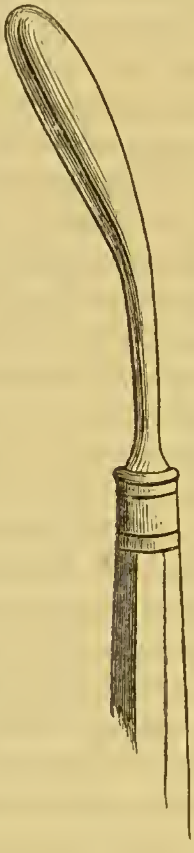
* American translation, by Atlee, p. 414.





This excessive secretion, depending on a morbid condition of the wide-spread pituitary membrane, may last for years, and eventually subside without any apparent structural change. It is, however, a source of annoyance to the patient, and must always be regarded with apprehension, because if persistent it may terminate in suppuration, associated with disease in the nasal bones and cartilages, and eventually produce irremediable deformity.

The annexed woodcut represents the *speculum nasi*, as contrived by Dr. Metz of Aix-la-Chapelle. It consists of two separate pieces; one to be held in the right, the other in the left hand. When introduced within the nostril, these serve to dilate, and at the same time to reflect light into the cavity. Before being used, they ought to be dipped in warm water, to prevent the polished plane being dimmed by the deposition of vapour.

The treatment consists in the exhibition of mercury, in continuous small doses. The bichloride of mercury may be given, to the extent of a sixteenth or eighth of a grain, twice daily, in a couple of ounces of distilled water; and persevered in for two or three months. Thus administered, it exercises both an alterative and tonic action; seldom giving rise to ptyalism, or producing any inconvenience except a slight tenderness in the roof of the mouth. Or a single grain of blue pill or gray powder may be given every night, for a similar period. In chronic diseases, as Dr. Graves justly remarks, the beneficial influence of mercury is best obtained when given in continuous small doses; and this rule applies especially to those obstinate cases of constitutional syphilitic affection we sometimes meet with, which last for years in spite of all treatment. Should there be any erosion of the pituitary membrane, benefit will accrue from the administration of iodide of potassium or sodium, alternated with the mercury, and given in adequate doses at suitable intervals.* As regards local treatment, the object here is to change the action of the mucous membrane, and to shield it from the influence of external impressions. The former indication is best fulfilled by pencilling the internal surface, once in two days, with a solution of nitrate of silver containing from four to ten grains to the ounce of distilled water; or by injecting daily a solution of alum of two grains to the ounce. By acting in this way on the mucous membrane at the outlet of the nostrils, a healthy action will often be induced, which spreads to the vicinity. Mr. Langston Parker recommends the vapour of calomel, directed by a simple process into the nasal fossæ, for a few minutes daily. Blistering the nape of the neck is another mode of treatment. To shield the lining membrane, cold cream, or an ointment containing a little calomel, oxide of zinc, or bismuth, may be used.

In patients of a delicate strumous habit, syphilitic ozæna is prone to supervene. This is attended with caries and necrosis of the nasal bones, as also of the vomer and perpendicular plate of the ethmoid bone, with more or less destruction of the cartilages. These eventually exfoliate, and sinking of the bridge of the nose is a common result. During the process of exfoliation, the discharge from the nostrils acquires an intolerable smell, becomes profuse, and may be attended with attacks of hæmorrhage from the nose, ulceration of the fauces, and violent pain extending from the pharynx along the Eustachian tube to the tympanum, and deafness. Should the affection engage the delicate, porous, and seemingly worm-eaten, bony lamellæ of the ethmoidal cells, it may commit sad havoc, transforming the mouth and nose into one cavity with nude bony walls. In the event of the integument in this situation having been destroyed, the movements of the epiglottis are brought into view. The hideous devastation thus produced is well exemplified in the instance of a skull preserved in the museum of St. Mary's Hospital, as also in a wax model of the patient's head and face taken immediately after death. She had been under the care of Mr. Lane, in the Lock Hospital. In this skull there is a large opening three inches wide by two in height, occupying the whole of the forehead; the frontal bone around this is very much thickened, the frontal sinuses on the left side are opened; the nasal bones, the ascending and palatine processes of both superior maxillary bones, with the anterior halves of their alveoli, the inferior turbinated bone, the vomer, a part of the palate bones, and most of the ethmoid, are completely destroyed; the ethmoid and sphenoidal cells are extensively opened; and the *antra Highmoriana* completely laid into the cavity of the nose. A sequestrum comprises nearly the whole of the vertical plate of the frontal bone, the right nasal, the ascending process of the superior maxillary bone, and a small portion of the alveolus. The frontal bone is a good deal thickened from the effects of the disease, and, with the other bones, has a slightly porous appearance.

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* The following formula will generally be found to agree: ℞ potassii iodidi, potass. bicarb. āā gr. x., syrup. sarzæ co. ʒij., aquæ ad ℥iv. M. fiat haustus bis terve in dies sumendus. The sarza serves as a demulcent.

Protracted cases of syphilitic coryza must be viewed with apprehension also, from the risk of danger of serious cerebral affection supervening, as illustrated in Dr. Weber's paper on the subject, published in the 43d volume of the *Medico-Chirurgical Transactions*. Among other cases, the author gives the details of one of syphilitic ozæna, in which head symptoms appeared soon after cessation of sanious discharge; rigors four days later; pyæmia; and death on the thirteenth day after the first rigors. Cadaveric inspection revealed thrombosis of the cavernous sinus and ophthalmic vein of the left side, as also of the longitudinal, and to a lesser degree of the circular and right cavernous sinus; purulent meningitis on the inferior surface of the left anterior lobe; secondary abscesses in the lungs and liver, and purulent effusion in the left pleural cavity.

It has been asserted that caries and destruction of the bones are seldom or never observed except where mercury has been administered. Such is not the fact. I have seen instances of destruction of bone, and consequent deformity, the sequel of venereal disease where not a particle of mercury had been taken. Sir B. C. Brodie mentions a case in point. A gentleman had chancre; no mercury was exhibited. In two years afterwards he had extensive disease of the bones of the nose. He had a fit of epilepsy; this was succeeded by a second and a third. He became maniacal, and died. Sir B. C. Brodie never doubted that the disease had crept up the ethmoid cells, affected the cribriform lamella of the ethmoid bone, and ultimately the brain and its membranes.* Dr. Graves, moreover, alludes to two analogous cases, in which the scrofulous diathesis was preëminently marked, and the affection of the bones, which the venereal poison exhibited, immediately degenerated from its usual course, and assumed all the characters of scrofulous disease. In both instances, destruction of the nasal bones, and consequent sinking of the bridge of the nose, occurred.†

As regards treatment, the main reliance must be on the preparations of iodine. The waters of Aix-la-Chapelle have been found serviceable, as I learned from Dr. Diemer, a skilful physician practising there, in virtue of the alterative and invigorating influence which they exercise on the system. Cod-liver oil and chalybeates will be occasionally indicated. As a general rule, mercury is prejudicial where the bones and cartilages are deeply affected; but should none of the metal have been previously exhibited, minute doses of the bichloride may prove advantageous. The local means consist of the removal of crusts, warm fomentations, and injections. As injections, a weak solution of chloride of zinc or bichloride of mercury may be resorted to, in the proportion of half a grain to the ounce of distilled water. Inhalation of mercurial vapour is recommended by some practitioners. In the event of head symptoms coming on, leeching the scalp has peculiar advantages, from the intimate connexion between the scalp and the surface of the brain. Counter-stimulants, as blisters, to the nape are valuable auxiliaries.

Ulcers of the nasal fossæ. Ulcers of these cavities are sometimes the sequel of a cold. I was consulted by a gentleman aged fifty-two, who had been thirty years in India, on account of an oval patch of ulceration in the right nostril, just by the lower margin of the superior lateral cartilage. It was covered with a crust, and was the seat of irritation. It commenced six months previously from a cold. Ulcers in this situation more frequently result, however, from a scrofulous or syphilitic taint in the system. They are ordinarily slow of healing, because the cellular tissue in this locality is very dense, and by no means favourable to allowing the margins of the solution of continuity to come near each other; accordingly, the resulting cicatrice is always large, or else there is loss of substance with perforation. The sores, moreover, are constantly imbued with a more or less acrid secretion, and being frequently the seat of itching or of uneasy sensation are fretted by the repeated contact of the patient's finger. Ulcers may assail any part of the nasal fossæ, but are most common on the septum, just where the cartilage is connected with the bone. Sometimes this merely amounts to erosion, the mucous membrane having scarcely lost its polish. At other times it is a distinct ulceration, the surface of which is plainly granular, and covered with a crust. The patients are led to detach the crust with their fingers, when bleeding may ensue.

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* *London Medical Gazette* for 1844.

† *Clinical Lectures*, 2d edit. vol. ii. p. 484.

Ulceration here may be simple and benign, the secretion exhaling no perceptible odour; or it may be of a different nature, and emit a highly offensive smell: hence the term *ozæna*, derived from the Greek *ὄζη*, stench. The cause of ozæna is often obscure. The affection is observed in individuals of vigorous constitution, as well as in those whose system is contaminated by syphilis or scrofula. It is often met with in persons who have a broad and flattened nose, which the French term *écrasé*, and which may have resulted from hereditary syphilis. According to M. Trousseau, one of the earliest and most characteristic signs of the appearance of syphilis in the infant is a coryza, which begins at first with mucous secretion, followed by serous and purulent discharges, and by hæmorrhage of greater or less frequency, and terminates in caries and deformity of the nasal bones. Now, I believe a persistence of this condition will give rise to ozæna. In some of those obscure cases which are characterised merely by the offensive smell, when there is no discharge of matter, no pain, and nothing preternatural to be perceived in the nares, the cause may be a fragment of carious or necrosed bone pent up in some crypt or other of this region.

The affection commences in infancy or in adolescence, and in either case frequently lasts through life. The stench is the first sign which attracts attention, and is sometimes, as above stated, the only one. In a case of this description which came under my care some time back in St. Mary's Hospital, the subject was a short stout-made young woman, twenty years of age. She had from earliest childhood been affected with a discharge of a greenish colour and fœtid smell from both nostrils, with occasional pain of a shooting character referred to the root of the nose. She had the *nez écrasé* or flattened nose, with superficial ulceration of the mucous membrane of the roof of the left nostril. Here a piece of carious bone had been removed at a former period by a Surgeon. She improved under the use of remedies, but was not cured. Indeed, ozæna is rarely cured, except perchance at its outset, and that in young subjects. In some instances it has been known to subside on the establishment of menstruation, or after childbirth. The treatment resolves itself into the employment of chlorinated injections to correct the fœtor, and of various stimulant and astringent applications to modify the vitality of the pituitary membrane; such as, very dilute solutions of nitrate of silver, chloride of zinc, and sulphate of copper. Dr. Gross recommends an injection containing three grains of tannin and a quarter of a grain of sulphate of copper to an ounce of distilled water. A dilute solution of creosote, carbolic acid, or permanganate of potash, will sometimes be of service. The insufflation of calomel, conjoined with an injection of bichloride of mercury, is extolled by M. Trousseau. Where the irritation has persisted for a period of years, and is attended with superficial erosion of the mucous membrane, I have prescribed with advantage a liniment composed of one ounce of olive-oil, with fifteen grains of chloride of zinc. The affected part is to be pencilled over with the liniment once a day. A peculiar caustic-holder for applying nitrate of silver, in cases of ozæna, has been devised by M. Cazenave.

Epistaxis, or bleeding from the nose. The arteries of the nostrils spring from the ethmoidal, spheno-palatine, posterior palatine, and facial branches. Their veins are almost all satellites of the arteries; some of them, however, traverse merely the body of the sphenoid bone, and the fronto-ethmoidal foramen, to arrive at the sinuses of the dura mater. These last are the *emissary* veins, which have no analogy with the arteries in their distribution, but which establish between the nostrils and the cranial veins an intimate communication. This may be noticed, in passing, as important in a medical point of view, because it accounts for the bleeding from the nose which occurs so frequently in cases of obstinate cephalalgia, and also for the efficacy of derivative abstractions of blood from the nostrils under such circumstances.

Hæmorrhage from the nose may be either spontaneous, as in the instance above alluded to, or traumatic, the result of injury or surgical operation implicating the parietes of the cavity.

Spontaneous bleeding from the nose may be active or passive. In the former case it is due to rupture of vessels which are overfilled, or to a mere sanguineous exhalation independently of any textural lesion; and is preceded by a sense of fulness and weight in the frontal sinuses, redness of the eyes and face, and a peculiar buzzing in the ears. It occurs chiefly in young persons up to the period of puberty, or a little beyond. In the latter case, the hæmorrhage is also due to an exhalation of blood, but connected with an enfeebled state of the vascular system, and not announced by any precursory signs. It is ordinarily symptomatic of scurvy.

Spontaneous bleeding may generally be stopped by the application of cold to the forehead, or introducing a piece of lint soaked in some alcoholic tincture, as that of benzoin, or in some styptic solution, into the nostrils. In active hæmorrhage it has been recommended when the blood flows from one nostril to elevate the corresponding arm in a vertical position; and when it flows from both nostrils, to elevate both arms. The propelling force of the heart is thus distributed, because, having to urge a column of blood up the arteries of the arms, it must act with less momentum on the carotids. I have seen the plan successful. M. Malgaigne, in his work on Fractures, mentions a case in point. A young man had been thrown down with his face to the ground, and sustained a fracture of the nose, from which there was copious bleeding. Cold lotions having failed to check the latter, he was directed to raise his arm perpendicularly; the hæmorrhage ceased immediately, and did not recur. The late Mr. Vincent strongly advocated the importance of keeping the bleeding vessel free from all coagulum, in order to suppress hæmorrhage. The plan of proceeding which he adopted for this purpose in epistaxis was to syringe the nostrils, so as to wash the blood out. If the syringing be continued until the bleeding ceases, it will not only stop, but not recur. The water need not be cold; indeed he found that arteries will contract under the use of warm water, which has a better effect in clearing away the clots, and keeping the parts free from blood. In epistaxis resulting from a scorbutic taint, benefit will be derived, in many cases, from the administration of oil of turpentine. Dr. Graves* witnessed the greatest advantage from dry-cupping in some forms of epistaxis, in which complaint, he says, much benefit is frequently derived from the application of cups to the nape of the neck, especially when employed to arrest the paroxysms, in cases where the precursory symptoms of a well-marked character precede the attack of bleeding from the nose.

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* *Clinical Lectures*, vol. ii. p. 310.

Should the hæmorrhage not yield to the means above specified, then recourse must be had to plugging the posterior nares. This applies to those cases in which the blood, being prevented from flowing out of the nostrils anteriorly, makes its way down the throat. This may be effected in various ways, and ingenious instruments, as that of Bellocq and others, have been devised for the purpose; but perhaps the most ready method is that recommended by Mr. Syme. It is "to pass a probe, curved to the form of the palate, through the nose into the pharynx, and then draw it out of the mouth, conveying by its means a piece of strong ligature, about a foot and a half in length. A compress of lint, large enough to obstruct the posterior opening of the nostril, is next tied securely to the middle of the thread which issues from the mouth. The other end being pulled, this plug is drawn backwards, and, with the assistance of the operator's fore-finger, is lodged behind the soft palate at the nasal orifice, where it compresses directly the naso-palatine artery. The two ends of the thread are then secured; and when it is judged safe to remove the plug, the thread that lies in the mouth affords the ready means of doing so."*

Polypus. The nose is the most frequent seat of polypus. The ordinary kind is the mucous, gelatinous, or vesicular, termed also benign. This, as its name implies, is of a soft, pulpy, somewhat elastic consistence; of a palish or grayish light-brown, or greenish colour, or looking like a membrane just going to be sloughy, as Mr. Pott observed; partially translucent, and invested by a prolongation of the mucous membrane with its peculiar vibratile ciliæ. Examined microscopically, I find it to consist of an aggregation of translucent, amorphous molecular granules. The internal aspect of the lining membrane sends prolongations into the interior of the polypus, dividing it into compartments, which are frequently incomplete. The structure generally, in fact, is finely cellular. The surface presents a few straggling capillary vessels. The polypus is seldom if ever painful, nor does it become so on being pressed. It yields when submitted to pressure, or when cut into, a quantity of limpid serosity. It is, according to Rokitansky, of catarrhal origin. It is connected with the pituitary membrane, sometimes by a narrow and more or less elongated peduncle, sometimes by a broad base. It is usually attached to the superior and external wall of the nostril, but occasionally proceeds from the ethmoidal cells, the lower meatus, or the thick mucous membrane covering the inferior turbinated bone. It is scarcely ever met with on the septum. There may be but one polypus, but it not unfrequently happens that there are several at the same time, each of which is perfectly distinct from the others, and has a separable distinct attachment. When such is the case, the lowest or most anterior, having the open nostril before it, easily makes its way down uncompressed; while the others are not only kept up and out of sight, but are also considerably compressed. Polypi tend to increase in size, and may thus fill one-half or three-fourths of the nasal fossæ on both sides, and project either forwards or backwards. The growth may pass backwards in the fauces behind the uvula, and hang down into the pharynx. It seldom exercises any action on the bones, beyond occasionally stripping them of their investing membrane; but this of course may lead to necrosis. In a lady, thirty-eight years of age, who had been many years afflicted with mucous polypus, and whom I eventually cured by extraction, I found the internal osseous structure quite denuded. When the polypous growth has advanced forward, it may displace the cartilages, and cause considerable expansion of the nostril.

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* *Principles of Surgery*, p. 473.

From peculiarity of structure, this polypus is of a hygrometric character, diminishing in dry warm weather, and becoming longer, falling down lower, and looking fuller and paler in moist or wet. It may occur at any period of life, but is most common in adults.

The symptoms are, a sense of fulness and weight in the nostril, as if proceeding from a cold. Indeed, for a considerable time before the polypus becomes visible, the patients feel to be perpetually catching cold, although seldom troubled with other symptoms than a stoppage in and discharge from the nose. In moist weather, or in a sudden change from dry to wet, they are also subject to frequent fits of sneezing; and when the relaxed membrane is most affected, to a considerable discharge of thin mucus from the affected nostril. Presently other symptoms supervene, as the growth becomes developed. The respiration through the nares becomes more and more embarrassed, so that patients are obliged, particularly during the night, to lie with the mouth open and the head thrown back, and they make a loud snoring when asleep. They feel, moreover, as if there were some fleshy substance in the nostril, and are prone to make frequent and ineffectual efforts to get rid of it by blowing the nose. At this stage the polypus ascends and descends by the action of respiration, and the patient can make it descend by stopping the nostril which is free or partially free, and then driving the air through that which the polypus occupies. The voice seldom remains natural, but becomes nasal, indistinct, and even snuffling. The sense of smell and that of taste are impaired, or abolished. Deafness is a frequent concomitant, and is due, as Mr. Toynbee informs me, to a co-existent thickening of the membrane of the tympanum. The above symptoms are most marked in damp weather, for the reason above assigned.

In order to ascertain the presence of polypus, the patient's head must be thrown back, and the nostril dilated by means of the speculum delineated at p. 204. With a clear light the adventitious growth is then brought into view, with its glistening surface coated with mucus, and round its lower and visible part a probe can readily be passed, and that to some height. In some instances, by carrying the finger underneath and behind the soft palate, the polypus may be tilted up; moreover, on directing the patient to breathe by the affected nostril, it is found that the air does not pass, or does so with a whizzing sound. In these trials, the patient experiences the sensation of some body shifting its place within the nasal cavity; and at times the Surgeon perceives a peculiar noise, which Dupuytren likened to the flapping of a flag.

As regards diagnosis, polypus in its nascent stage may be mistaken for coryza, but only then. It is simulated by thickening of the membrane covering the inferior turbinated bone, which is frequent in children, and by displacement of the septum, which is present in most people to a slight degree, and has occasionally encroached on the nostril so as to cause inconvenience. In a case of this description, an inexperienced practitioner, believing he had to do with a polypus in a young lady, tore away a portion of the membrane, and laid bare the bone. Lastly, an extraneous substance, as a fruit-stone, or a calculus, has been taken for a polypus. By attentive consideration, however, of the symptoms above detailed, and the progress of the case, error may generally be avoided on the part of the Surgeon.

It is not always easy to ascertain the exact point of attachment of the polypus, or whether the growth is solitary or multiform, as the introduction of a probe to any distance produces a degree of tickling which few patients can well endure.

The polypus is a complaint which is always troublesome, but not generally serious. Every now and then it subsides spontaneously; and is almost always removable without much pain, hæmorrhage, or hazard of any kind.

There is a form of polypus which is frequently an elongation of the membrane covering one of the turbinated bones, and which, though plainly movable, is considerably less so than the ordinary vesicular, is less liable to alteration from air and seasons, and is rather slow in its progress. M. Robin has described another variety, which is due to hypertrophy of the glands of the mucous membrane. The tumour recurred thrice after removal. The patient died of an intercurrent affection. Examination after death revealed a considerable thickening of the mucous membrane of the upper part of the nasal cavity, and a tumour implanted on the cribriform fossa of the ethmoid bone. The tumour and the thickened mucous membrane contained a great quantity of cells of cylindrical epithelium, similar to those which are met with in the natural state of the pituitary membrane. This differed from the ordinary polypus both in the extent of implantation and in the thickening of the mucous membrane.*

Treatment. The method generally resorted to is extraction with forceps, by a sort of compound movement of pulling and turning. Straight forceps, of moderate size, commonly answer the purpose. Curved forceps may be employed when the polypus is situate far back, and has to be removed by the mouth. Ordinarily the two branches of the forceps have a fixed joint; but advantage will occasionally be found in using an instrument so constructed that the branches can be introduced separately, like those used in midwifery, and conjoined at the moment of seizing the polypus. The patient is to be seated on a somewhat high chair, facing the light, the head thrown back and supported by an assistant, who at the same time elevates the point of the nose. The Surgeon placed in front introduces the forceps, with closed blades, into the nose, along the septum; and as the spongy bones are attached to the outer wall of the nasal cavity and do not extend to the septum, the forceps will be more readily opened in a vertical than in a transverse direction. The forceps is to be opened so soon as the polypus is reached, and conveyed as far back as practicable, in order to grasp the stalk or peduncle. It must then be tightly closed, and traction and rotation simultaneously performed, till the polypus is extracted.

Frequently the polypus yields and comes out of the nostril, without separating, however, from the pituitary membrane. In this case it must be grasped close to its root with a second forceps, and the same movements of torsion and traction continued until its entire avulsion is accomplished. In carrying a straight instrument into the lower meatus, it should be borne in mind that the outer nasal openings lie somewhat deeper than the floor of the nasal cavity; hence the propriety of pressing the nose somewhat upwards.

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* *Gazette des Hôpitaux*, 1852, p. 46.

It is not always possible to clear the nostril of polypi at a single sitting. It is therefore necessary to repeat the manœuvre above described at suitable intervals, until the patient is able to breathe freely through the nostril. Even then, polypi may form again in the course of a few weeks or months, and necessitate a renewal of the proceeding.

When a polypus is situate backward in the fauces, descending into the pharynx, it may be seized through the mouth and drawn downwards and forwards by a sort of lateral movement of the instrument, for here torsion cannot be executed. The forceps curved at the extremity, and with branches which come apart, will be found convenient. This, though occasionally practicable, is more easily described than accomplished, and in some people will be found impracticable. "The objection arises," as Mr. Pott clearly pointed out, "from the great difficulty of keeping the tongue down in some individuals, and in others from their incapability of permitting any thing to touch the root of that part, or any part of the fauces, without immediately producing a spasm; to which might be added, that in some cases the polypus is so expanded as almost to conceal the uvula, which is therefore liable to be laid hold of by the instrument, to the no small detriment of the patient."

Under such circumstances, Mr. Syme considers that the principal part of the tumour may, perhaps, be removed by introducing the loop of a doubled silver wire through the nose into the pharynx, guiding it with the finger round the body of the growth, and then pulling the wire so as to draw it up to the neck or thin part near the roof. But it is a far better plan, he remarks, to detach the polypus by seizing its roots with forceps introduced through the nostril, and then to push it into the throat.*

There is a method of removing polypi of the nasal fossæ simply with the forefingers. One of these is thrust into the nostril, while the other is introduced through the mouth behind the palate. When they have reached the growth, they are pushed alternately forwards and backwards until all resistance has ceased, and the substance is withdrawn through the nearest opening. Morand and Sabatier succeeded thus; but the procedure, though simple, is rarely admissible, and only for polypus occupying the floor of the nasal fossæ; for if implanted high up, it is obviously inaccessible to the fingers of the Surgeon. Mr. Hilton recommends what he terms a *snare* for getting rid of this complaint. Dr. M'Ruer, an American physician, extols the following plan: a piece of catgut is passed from the nostrils to the mouth, to which is fastened a piece of soft and dry sponge, corresponding in size, when firmly compressed, to the narrowest part of the nasal passage; it is then drawn gently forwards by the posterior fauces through the nose. He thus succeeded in at least ten cases in bringing away all the adventitious growths.

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* Op. cit. p. 476.

Formerly attempts were made to remove polypus by the use of escharotics or exsiccatives, and by excision; but these are long since abandoned, as found impracticable. It only remains to point attention to the employment of the ligature. The method of ligature, whether of silk or wire, is certainly feasible in some instances; but, as Mr. Pott* justly observed long since, is by no means equal to that by the forceps, either for its general utility, or its capacity of perfectly eradicating the excrescence. It is considered most suitable for polypi which are pedunculate and too bulky to be grasped by forceps, and for those which are situate on the floor of the nasal fossæ, or on the superior wall near the pharynx. To surmount the difficulties which are so frequently encountered in the execution of this operation, a variety of ingenious instruments have at different times been brought before the notice of the profession, more especially by Ambrose Paré, Desault, Levret, Brasdor, and Hatin. The object of the ligature, which must necessarily be drawn tight, is to determine strangulation and separation of the polypus in the form of a slough.

Mr. Fergusson gives the following plain directions for applying the ligature when the polypus is of large size: A piece of catgut or of silver-wire, twelve or eighteen inches long, should be doubled, care being taken not to injure its elasticity at the bend; this part should then be pushed along the floor until it reaches the pharynx, where it will be allowed to expand; and at this stage the point of the forefinger, or forceps of convenient length, should be passed along the mouth into the throat, and so managed as to push the catgut or wire behind and above the growth. When this is accomplished, the ends must be introduced through a small double canula, which should be slid along upon them as high up as the root of the disease seems to extend, and thus the noose will be further up than the finger can push it; one end of the ligature may then be fastened to the ring at the end of the canula, and the other must be drawn so tight as to obstruct all circulation in the part; it may then, if allowed to remain, be fixed to the ring of the tube, and tightened from day to day until the separation is effected.* If it could be effected with safety, Mr. Fergusson would on all occasions separate the part at once, instead of letting it slough, being careful at the time lest it drop into the lower part of the pharynx, or cover the orifice of the larynx, and cause suffocation. During the process of sloughing in this region, there is a risk of fatal contamination of the system from morbid secretion, unless the patient is steadily kept with his head inclined forwards. M. Vidal witnessed an instance of an individual being thus poisoned, after a rhinoplastic operation. There was suppuration of the flap; the precaution was not observed to maintain the head bent forwards, the matter gravitated from the nose into the mouth, was swallowed during sleep, and the patient succumbed with all the symptoms which are attributed to putrid infection. On cadaveric inspection, no lesion of tissue was perceptible which could account for death.†

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* *Chirurgical Observations*, p. 57.

Hence, in order to remove, at once, polypous growths from the posterior nares, M. Maisonneuve has resorted to what he calls the *boutonnière palatine*, and with the most satisfactory results. This little operation consists in making a button-hole-like incision in the soft palate, and in drawing the polypus through the opening into the mouth, where it is an easy matter to apply a ligature, or to use the knife. The great elasticity of the parts composing the soft palate allows the polypus to be drawn through a comparatively small opening, and after the operation is completed, the same elasticity will generally serve to close the opening without the help of suture. The direction of the *button-hole* is from before backwards.‡ In like manner, Mann, a Surgeon of Avignon, in the year 1747, had a difficult case, in which he was obliged to slit the soft palate in the median line to remove at different times different portions of the tumour, and to introduce into that which remained several threads forming a noose, with which he drew forwards the polypus, whilst the fingers introduced through the mouth pushed it in the same direction. The tumour gave way, its peduncle ruptured, and the noise which it made in traversing the nostril resembled the uncorking of a bottle. A second polypus showed itself a few days afterwards, which in its turn was extracted, and the cure was complete.*

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* *Practical Surgery*, 3d edit. p. 580.

† *Traité de Pathologie externe*, 1861, tom. iii. p. 464.

‡ *Comptes rendus*, août 1859; and Ranking's *Half-yearly Abstract* for 1859, p. 196.

The other form of polypus which demands notice is the fibrous. It is distinguished by the extreme firmness of its texture, and is composed of fibres, crossing in different directions. It is implanted on the fibrous layer which lines the mucous membrane, and which serves as periosteum to the nasal fossæ. The base is broad or pedunculate. This variety of polypus is much more vascular than the gelatinous, and for the most part solitary. It may displace the bony structures which stand in the way of its development, as well as the septum, depress the palate, cause the proper bones of the nose to project, induce atrophy and even perforation of the bones, and may eventually make its way into the orbit or cranium. The tissue of this variety of polypus is susceptible, according to M. H. Cloquet, of becoming accidentally incrusted with phosphate of lime, and undergoing partial ossification, by a phenomenon analogous to what is observed in certain wens. This transformation causes no other inconvenience than that resulting from the size and situation of the growth.†

The symptoms differ but little from those of the preceding variety; hence the diagnosis is sometimes perplexing. It may be remarked, however, that the fibrous polypus is not influenced by hygrometric changes; and the finger introduced into the nostril touches a hard resistent tumour instead of a soft elastic substance like an oyster; lastly, when the disease is of some standing, there is the misshapen nose, imparting, what has been termed, the *frog-face.*

This is a more serious affection than the former, not merely owing to the bony distortion which may ensue, but because offsets are sent into the various sinuses lodged in the frontal, ethmoid, and superior maxillary bones, which render the removal, in totality, a difficult matter.

In certain cases, the fibrous polypus may be extracted with forceps, or tied when pedunculate, and especially when it has cleared the posterior opening of the nostril, and is prolonged into the pharynx. But when these excrescences have a large base, and fill the nasal fossa, the walls of which they have misplaced, their ligation is impracticable, their avulsion can only be partial, and what remains behind grows with fresh energy, takes on an unhealthy character, and generally leads to a fatal termination. Excision has sometimes proved successful. A polypous growth of this description filled the left nostril, issued in part by the nose, enlarging like a mushroom, and passed into the throat, where it formed a considerable tumour. Ledran seized with the fingers the portion which emerged from the nose, and, drawing it towards him, cut it in the nostril as high as possible. He next introduced his finger into the fauces, beyond the soft palate, and by means of curved scissors was able to remove considerable portions of the tumour. The discharge of blood obliged this eminent Surgeon to suspend the operation; but having introduced the finger into the nostril, he ascertained the point where the tumour originated, and with scissors and a bistoury he removed it entirely. The bleeding was considerable, but soon yielded to plugging. In a troublesome case of this description, Mr. Whately employed successfully a narrow straight bistoury with a probe-point, having a sheath fixed upon its edge by a screw put into a hole in the handle; an eye being made at its point to receive one end of a thread, intended to be passed round the polypus, for the purpose of directing the knife to the neck of the tumour.*

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* H. Cloquet, *Osphrésiologie,* p. 668.

† Op. cit. p. 688.

The most formidable variety of polypous growth of this nature is the naso-pharyngeal properly so-called. It has only one mode of insertion, namely, at the base of the cranium on the basilar process (at the superior part of the lower face of this process), and at that part of the sphenoid bone which articulates with it in the upper portions of the pterygoid fossæ and the internal wings of the pterygoid processes. These insertions occur in a space comprised on one side between the posterior wall of the sphenoidal articulation of the vomer, and the insertions of the rectus capitis anticus major muscle (from half an inch to an inch), and on the other side from one pterygoid fossa to the other. This is the primary insertion of the growth, which springs from the periosteum of the basilar process, and is very solid and thick at that point. The other implantations are consecutive or secondary, and more or less recent. They are readily accounted for, as follows: the polypus may ulcerate from friction, from undergoing compression, or other cause; it becomes inflamed, as does also the adjacent mucous membrane, and the ordinary result of this inflammation is an adherence between the polypus and this soft structure. These adhesions possess, in general, but little resistance, and are easily broken up. The naso-pharyngeal polypus is invested by the mucous membrane, frequently attenuated and ulcerated, sometimes preternaturally thick and red. The structure is composed of parallel fibres and fasciculi, which are inserted vertically on the bone; the centre contains but few blood-vessels; the surface is furrowed by numerous capillaries. It seems to possess but a low degree of vitality, as is shown by its being occasionally destroyed and removed by spontaneous sloughing. Two instances of this kind are pointed out in the *British Medical Journal* for January 1858; the one a patient under the care of Mr. Birkett, the other under that of Mr. H. C. Johnson. Both patients completely recovered, and no trace could be detected of any part of the morbid tissue remaining.

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* See *Cases of two extraordinary Polypi removed from the Nose*, London, 1805.

In addition to the ordinary symptoms produced by polypus may be noticed dyspnœa, which is observable when the tumour is rather bulky, and has descended low down in the pharynx; deafness, the consequence of pressure on the Eustachian tube, and hæmorrhage more or less copious. The diagnosis is in general obvious; the point most difficult to ascertain precisely is the number as also the size of the offsets.

The disease is one of a serious nature. According to M. Nélaton, who has devoted much attention to the subject,[*] individuals never live long with a growth of this kind. The tumour, when left to itself, unless removed by spontaneous sloughing, induces the death of the patient, either by hæmorrhage or by the obstacles which it offers to deglutition and to respiration, as in the oft-cited case of a man who died of suffocation from a polypus, which was attached not only to the vomer, but to the adjacent part of the occipital bone.[†] Its removal, besides, necessitates an operation of a dangerous character, under ordinary circumstances, and impracticable when the disease is far advanced.

The preliminary operations recommended for exposing the naso-pharyngeal polypus, and facilitating its removal, vary. Thus, an incision has been made into the nostrils, the proper bones of the nose have been removed, together with the ascending process of the superior maxillary bone; the soft and hard palate have been cut through; and lastly, resort has been had to resection of the superior maxillary bone.

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[*] *Compte rendu, Société de Chirurgie,* 1849.

[†] *Commerc. littér.* Norimb. ann. 1731.

Incision of the soft palate is not sufficient when the polypus is very far back. For this reason M. Nélaton has superadded resection of the hard palate. The following is his mode of procedure: 1. *Preliminary operations.* Incision of the velum palati in the median line; a mesial incision of the palatine mucous membrane from above downwards as far as the anterior half of the arch; two transverse incisions on each side of the anterior extremity of the latter; detachment of the palatine mucous membrane on each side to the extent of nearly half an inch with a blunt hook; perforation of the arch of the palate by means of a punch to the right and the left, at the level of the point of junction of the two incisions; section of the bony portion intermediate between the preceding perforations with bone-nippers; ablation of the bony fragment, comprising a portion of the arch of the palate and of the septum. 2. *Fundamental operation.* Direct excision of the polypous growth by means of scissors curved on the flat. 3. *Complementary operation.* No suture is to be employed, but on the following days the palatine mucous membrane, which has a tendency to reunite, is to be carefully detached, in order to allow of the application of caustic to the morbid tissue. In fine, about fifteen days after the first operation, repeated cauterisations are to be made to the root of the polypus with the solid Vienna caustic or strong nitric acid, which can then be brought into contact with the vault of the nasal fossæ through the persistent opening without any difficulty.

The mucous membrane is readily detached both right and left by the aid of the blunt hook. The section of the bone, too, is rapidly accomplished; it is simply necessary to act transversely with the bone-nippers, in order that each side of the palatine arch may be rent from before backwards. If this cannot be managed, it will be necessary to carry the nippers in this direction. The pituitary membrane, if not removed at the same time with the bony fragment, ought to be freely divided with a scalpel.

This operation is reckoned preferable to that by resection of the superior maxillary bone, because important parts are preserved which would otherwise be necessarily sacrificed. The main point here is the progressive destruction of the polypus by the potential cautery. This having been effected, the cleft in the palate may be afterwards remedied by staphyloraphy; and should it not contract sufficiently, the gap may be closed by a suitable obturator.

M. Maisonneuve radically cured, without disfigurement, a formidable case of polypus by the following procedure: by means of a strong pair of cutting forceps, one claw of which is introduced into the nostril and the other into the mouth, the palatine arch is at once divided; with the same forceps, one claw being retained in the nostril whilst the other embraces the outer surface of the maxilla, the operator effects a transverse section of the bone, which, from its no longer having any support, is readily removed; by this means the insertion of the polypus, which is easily extirpated, is exposed.*

It may be inferred from what is above stated, that the Surgeon need not hesitate to incise the soft palate and to cut away a portion of the palatine arch when a polypous growth situate at the back part of the nasal fossæ is of considerable volume or is multiform, because otherwise it is hardly possible to be sure that the disease can be completely extirpated. The removal of the whole of the superior maxillary bone affords undoubtedly the most certain method of eradicating the disease. This procedure has been had recourse to in France for this purpose during the last fifteen years, and no death is reported to have occurred after the operation. It appears from a case recorded in the *British Medical Journal* for January 1858, that Mr. Tatum was the first who performed in this country removal of the whole upper-jaw, in order to reach a fibrous tumour attached to the base of the skull. The operation was commenced by two incisions, so as to secure as free an opening as possible. The tumour, which was attached to the body of the sphenoid bone between the two pterygoid processes, was removed easily, and without any hæmorrhage; only a small branch of the internal maxillary artery required to be tied. The wounds healed in about ten days, and the patient, a lad aged sixteen years, made a good recovery. With respect to the preliminary steps of the operation, there can be no doubt that the parts are most clearly brought into view by means of two incisions: one slightly convex downwards and backwards, commencing at the commissure of the lips and terminating at the middle of the malar bone; the other incision severs the nostril from the ascending process of the superior maxillary bone. The excision of the bone is most readily effected by the aid of the powerful lever bone-nippers contrived by Mr. Hoffman, formerly of Margate.

There is a form of polypus so-called which is evidently malignant and carcinomatous in its nature. It attacks only adults, and begins with or is preceded by repeated discharges of blood, recurring without obvious cause or apparent lesion, and by considerable or frequent pain in the forehead and upper part of the nose. Presently a small tumour, either of a deeply red or of a dark purple colour, is to be seen at the upper part of one of the nostrils. It is painful to the touch, and when meddled with prone to bleed. It progressively and uniformly increases in size, and the compression which it exercises on the lachrymal sac, and on the nasal canal, gives rise to epiphora and to lachrymal tumour. Acute and lancinating pains accompany its development; and the common actions of coughing, sneezing, and blowing the nose give pain, or produce a disagreeable sensation in the nostril or forehead. Originating from the bone, it will be found to be fixed, and not movable by the action of blowing the nose, or of driving air through the affected nostril only. It encroaches by adhesion on neighbouring parts, producing thickening and enlargement of the septum. In the course of time the adjacent bony textures are implicated; the eye is frequently displaced. The tumour presents a fungous or medullary consistence and a livid colour, exhales a cadaverous odour, and sheds an offensive, ichorous, discoloured discharge. The disease goes on from bad to worse, and the patient, exhausted by pain and unrest, succumbs in a condition of cancerous cachexy.

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* *London Medical Review*, no. iv. p. 204.

In cases of this description removal by the forceps, or by any other means, ought not to be attempted, for reasons obviously deducible from the nature and circumstances of the growth. On the one hand, it is generally so extensive and adherent as to render complete extirpation impracticable; and on the other, all partial removal, all unsuccessful attempts on it, indeed any degree of irritation, will only tend to distress the patient. Palliative treatment is alone admissible. In certain cases the patient will be temporarily relieved by the Surgeon clearing the nostril with his finger of the morbid production. In the event of bleeding, the cavity may be stuffed with lint moistened with solution of tritochloride of iron. To allay pain, resort may be had to a lotion composed of one part of sedative solution of opium and two parts of water; or to one containing three drachms of extract of hemlock and one drachm of opium, in a pint of water.

ALEXANDER URE.

DISEASES OF THE LARYNX.

Acute Laryngitis.

ACUTE laryngitis is a formidable disease, which comes on very suddenly, and runs a rapidly fatal course, unless recognised early, and treated energetically.

The early symptoms are these: dryness and soreness of the throat, with difficult deglutition, accompanied by general fever and by much restlessness and anxiety. On inspecting the throat, the fauces are generally found deep red, and the epiglottis erect, red, and thickened, presenting to the finger somewhat the same sensation as a cherry would do. The patient will complain of soreness and a sense of constriction at the upper part of the throat, and tenderness of the larynx on pressure; and will probably point to the pomum Adami as the seat of his suffering. Dyspnœa soon comes on, and rapidly increases; expiration is at first performed with comparative ease, while inspiration is noisy, harsh, and whistling, and may be observed to be accompanied by diminished movement of the chest walls, and diminution of the respiratory murmur. The dyspnœa, though constant, is greatly aggravated at times, from spasm of the muscles of the glottis. Cough, if present, is frequent, harsh, and stridulous. The voice, at first harsh, becomes at last hardly audible.

As the disease proceeds and the glottis is more narrowed by effusion, the patient becomes extremely restless and distressed; he is unable to lie down; or if he does so, he starts up involuntarily, gasping for breath. The countenance is pale and anxious, the lips livid, the eyes protruding, sweat pours profusely from the forehead, the pulse becomes weak and intermittent, drowsiness and delirium supervene, and the patient dies suffocated.

This disease generally runs a rapid course, its duration depending on the intensity of the inflammation, on the constitution of the patient, and the nature and activity of the treatment adopted. It is generally fatal on the third or fourth day, and Dr. Watson mentions an instance in which a patient died in twelve hours. In some cases the disease is of a milder nature, and is not fatal until the eighth or ninth day; or it may subside, or pass gradually into a chronic form.

An examination after death of the morbid changes which have taken place will account for all the above symptoms, and explain the cause of the rapidly fatal nature of this disorder. The mucous membrane lining the cavity of the larynx is usually found reddened, thickened, and covered with a layer of soft yellow fibrin. The aperture of the glottis is narrowed from slight effusion of serum or pus into the submucous cellular tissue, the consequence of inflammatory congestion of the mucous membrane. The arytæno-epiglottidean folds and epiglottis are reddened and œdematous, and perhaps covered with a layer of soft fibrin. Ulceration of some part of the inflamed mucous membrane may occur, and even sloughing may take place.* It is usually said, that inflammation of the larynx does not extend into the trachea; in the fatal cases at St. George's Hospital, however, the trachea, and sometimes the bronchi, were occasionally found to present inflammatory changes similar to what have been described in the larynx, the mucous membrane being congested or highly vascular, and occasionally covered with a thin layer of soft yellow fibrin. The lungs, too, were often congested, and in some cases presented patches of hepatisation. The difficulty of deglutition, one of the earliest and most constant symptoms observed in this disease, depends on the swollen and painful state of the mucous membrane of the pharynx and larynx. The sense of suffocation which ensues on the patient attempting to swallow a morsel of food, is produced by the epiglottis being unable, from its tense and erect state, to perform its usual valvular office. But the most formidable symptom, the difficulty of breathing, is caused by the partial closure of the rima glottidis, from the effusion of fluid into the submucous tissue immediately above the vocal cords. A sufficient amount of air does not enter the lungs for the purpose of respiration, the pulmonary circulation is then retarded, carbonic acid accumulates in the blood, and, affecting the nerve-centres, produces delirium and coma; or, a sudden spasmodic attack of the muscles of the glottis ensues, in which the aperture of the glottis is so narrowed that the patient dies strangled; and such cases are fatal even in the earliest stages of the disease. A man was once admitted into St. George's Hospital, complaining merely of sore throat. He walked into the hospital, and seemed in such good health that he would not have been admitted, but for the circumstance of his having come some distance from the country. About three hours after his admission, the House-surgeon was summoned in all haste to see him, as he was said to be dying of suffocation. He went immediately, but found the patient quite dead. The post-mortem examination revealed all the evidences of laryngitis, supervening apparently upon inflammation of the pharynx; but it was especially remarked, that the chink of the glottis was not much narrowed from œdema. In this case there can be no doubt that death was produced by spasmodic contraction of the muscles of the glottis.

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* A preparation illustrating this latter condition is in the museum of St. George's Hospital.

Acute laryngitis generally attacks adults of plethoric habit. It is frequently produced by exposure to wet and cold, or sudden and extreme changes of temperature. It is a common result of mechanical violence, or of chemical injury, as in attempting to swallow corrosive poisons or boiling water. It has been known to follow a bungling attempt to introduce the stomach-pump in a case of poisoning; and in another case followed the incautious application of ammonia to the nostrils. It may also occur in connexion with those diseases which affect the parts in the immediate neighbourhood of the larynx. Those who suffer from chronic sore throat appear to be very liable to its attacks. I have seen it occur in connexion with ordinary glossitis. It occasionally follows an attack of cynanche tonsillaris, or inflammation of the fauces and pharynx, or the affection of the throat in scarlet fever, or occurs in connexion with erysipelas of the face and scalp; and in a few instances has been known to follow excessive salivation from the exhibition of mercury.*

Diagnosis. The symptoms of this disease are usually so distinct that there are few affections with which it can be confounded. The pain, soreness, and sense of constriction in the region of the larynx; the difficulty of respiration and deglutition, ushered in by fever and rapidly followed by spasms of the laryngeal muscles, producing danger of suffocation, are very indicative of its true nature. Croup may be known from laryngitis by the peculiar cough, the more stridulous breathing, and the presence of the voice. Laryngitis may be distinguished from a foreign body in the air-passages by the absence of fever, and the suddenness of the accession of dyspnœa in the latter injury. Great difficulty of breathing may exist in cynanche tonsillaris, but then the swelling which produces it is visible on examining the fauces; whereas in laryngitis the amount of swelling in this situation, if any exists, is quite insufficient to account for the extreme difficulty of breathing and deglutition. In pharyngitis there is little or no dyspnœa; but deglutition is painful and difficult, and pain is felt on pressing the larynx backwards.

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* See a preparation, with its history, in the museum of St. George's Hospital: series xv. subseries i. no. 6.

The *treatment* of this disease must vary according to the progress it has made; a mode of treatment that might be most efficacious at the onset of the malady, would only hasten a fatal termination if adopted later. If the case is seen in the early stage of the disease, the stage, that is, of active inflammation, the most vigorous antiphlogistic treatment should be adopted. The patient should be bled, the amount of blood to be taken being modified according to the age and constitution; or cupping, to the nape of the neck, leeches or blisters at the upper and front part of the chest, may be tried. Mercury should be administered, so as rapidly to affect the system. Tartar emetic, if used, should be given in such doses as to diminish the circulation, but not to cause vomiting, since the contents of the stomach might enter the larynx, and produce suffocation. No time should be lost in adopting this treatment; the only chance of its success is in enforcing it at the right moment, and in the most vigorous manner. The time for bleeding has past when respiration becomes greatly obstructed; and this may be known by the leaden hue of the features, blueness of the lips, a cold clammy skin, and feeble pulse. Bleeding under such circumstances would be worse than injurious; it would probably be fatal. If the Surgeon finds that the antiphlogistic treatment fails, or if he has been first summoned to the case in its more advanced stage, he should at once propose tracheotomy. The records of numerous cases, however, show so clearly the efficacy of the antiphlogistic treatment in the early stages of the disease, that such treatment should never be omitted when inflammatory fever is present. On the other hand, when the necessity for the operation is apparent, no time should be lost in performing it. There are many advantages in performing tracheotomy early in this disease. It prevents the occurrence of those frightful paroxysms of dyspnœa, in one of which the patient may die suffocated. It allows repose too of the organ, if the trachea is opened below the obstructed part. The patient may then continue to breathe, until the inflammation of the larynx subsides, and the thickening and œdema is removed by absorption.

Porter says, "I have witnessed many operations in cases of acute laryngitis, and as yet have seen but few successful; and I would attribute this not either to the severity of the affection or to the inadequacy of the operation to procure relief, but solely to the circumstance of a considerable portion of time being previously employed in trying to subdue it by the usual measures for combating inflammation, and the use of the knife being thus postponed until a period when it was only tried as a last recourse, and could by no means promise even a probable chance of success."* Louis, Lawrence, and Watson also advocate early performance of the operation.

Tracheotomy, however, is not proposed as a means of cure in this disease, and should never be regarded as a remedy to be adopted when other milder means have failed, but only as a resource for the prolongation of life while the powers of nature, or the treatment adopted, remove the inflammatory effusion. Nor should the operation be omitted even in cases where there is little apparent chance of success. Dr. Watson has recorded numerous cases in which tracheotomy has been successfully performed after the breathing and pulse had ceased. In favourable cases the operation is followed by great relief to the distress and anxiety; respiration becomes free, and the patient sinks into a deep repose. The subsequent treatment will depend on the nature of the general symptoms.

Œdema of the Glottis.

Although considerable œdema may exist in connexion with ordinary acute laryngitis, it is important to draw a distinction between that disease and the one under consideration. Œdema of the glottis consists in an effusion of serum or sero-purulent fluid in the submucous areolar tissue of the epiglottis, arytæno-epiglottidean folds, and upper part of the cavity of the larynx; the result probably of a low or asthenic form of inflammation, the free surface of the mucous membrane being unaffected.

The first thing noticed is a sensation of stiffness of the neck, or a feeling of uneasiness in the larynx. The attack is usually sudden, the patient retiring to bed, perhaps, in perfect health, and awaking in the night with extreme dyspnœa. There is a sensation as if mucus or some other foreign substance was clogging up the aperture of the larynx, or was lodged at the back of the fauces, and forcible attempts at expiration or deglutition are made to dislodge it. The voice is hoarse and croupal, and respiration is impeded; but there is probably no fever, no redness of the fauces, and the general health is not deranged. In the course of a few hours, or later, according as the disease is rapid or not, the voice becomes sharp and hissing; there is a hoarse spasmodic cough, and considerable dyspnœa; expiration is free, but inspiration is difficult, and accompanied with a crowing or stridulous sound. The difficulty of inspiration in this disease is accounted for by the mechanical arrangement of the swollen edges of the orifice of the larynx; for on every attempt to inspire, the air rushing from the pharynx in the direction of the larynx presses the sides of the opening together, closing it more or less completely; whereas during expiration, the air passing from the trachea separates the sides of the opening, and escapes easily. Pressure on the larynx produces very little uneasiness, and there is no difficulty in swallowing, as in laryngitis, unless the epiglottis is involved. The existence of œdema may be detected by introducing the index finger into the fauces, when the folds which bound the upper aperture of the larynx will be felt as two smooth rounded tumours just behind the swollen epiglottis. As the disease proceeds, the patient suffers from frequent fits of spasmodic dyspnœa; in some cases there are intervals of perfectly calm and easy breathing; in others, again, the spasmodic attacks are almost continuous, and one of them not unfrequently produces death. This disease is extremely fatal. Dr. Bayle has recorded only one recovery in seventeen cases; M. Valleix, in his essay on œdematous laryngeal disease, has collected and recorded forty cases, out of which number thirty-one were fatal; and in M. Sestier's memoir on the same subject, the results of 168 cases are given, of which number 127 died. The duration of the disease is usually from two to five days. In some cases death occurs more rapidly, being produced by rapid infiltration, or spasm of the glottis.

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* *Observations on the Surgical Pathology of the Larynx and Trachea*, p. 93.

The difficulty of respiration, which is the most marked symptom of this disease, is produced by rapid effusion of serum into the loose cellular tissue of the upper part of the larynx, and consequent approximation of the folds surrounding the upper aperture of the larynx and of the lips of the glottis; the œdema frequently extends to the base and sides of the epiglottis, and the base of the tongue and tonsils are frequently implicated; but it never extends below the true vocal cords, a fact clearly shown by Mr. Prescott Hewett.* The free surface of the mucous membrane is unaffected; the swollen parts are generally of a pale yellow colour, and devoid of vascularity. In the majority of cases of this affection, where it runs a rapid and fatal course, the effused fluid is serum or plastic lymph; but in more protracted cases it becomes sero-purulent or purulent. The causes of this disease do not in all cases appear to be very clearly understood. It may occur in consequence of exposure to cold, coming on suddenly, in persons of good health, and proving fatal in the course of a few hours. Bayle has noticed that it often arises during convalescence from fevers of a typhoid character. Not unfrequently it is coincident with some other disease of the larynx or adjoining parts; and it sometimes accompanies aneurism of the thoracic aorta, œdema being produced by obstruction of the veins leading from the part.

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* *Lond. Journ. of Med.*, vol. i. 1849, p. 129.

The treatment must be modified according to the stage of the disease, and the cause of the œdema. In the early stages of this affection, where the disease is apparently produced by local inflammation, the usual means of reducing inflammation should be adopted; but it must be remembered that the inflammation is of an asthenic character, so that general bleeding is rarely if ever required. Blood may be abstracted locally, by the application of leeches in the vicinity of the larynx; blisters should be applied to the back of the neck, or upper part of the front of the chest; and calomel may be given in large doses. But in the later stages of this affection, where there is much impediment to respiration, and where suffocation is imminent, laryngotomy should be instantly performed. The operation should not be delayed until the lungs are so far congested that their recovery is hopeless. Before performing this operation, it may be expedient to try Lisfranc's remedy of scarifying the œdematous swelling, so as to permit the escape of the effused fluid. This mode of treatment was adopted in five cases by Lisfranc with success; and Mr. Busk adopted it in two cases with permanent benefit. Numerous punctures were made with a sharp-pointed bistoury into the back of the tongue, the uvula, and the pharynx, and repeated every two or three hours; warm water being employed as a gargle in the intervals. The relief in each case was very decided. If œdema comes on in the course of any chronic laryngeal affection, or in connexion with aneurism of the thoracic aorta, laryngotomy is the only remedy that can be adopted.

Dr. Horace Green strongly recommends a solution of the nitrate of silver, a drachm to the ounce, to be freely applied to the epiglottis and cavity of the larynx. The first application he recommends to be made to the pharynx and upper surface of the epiglottis, the application being repeated in ten or fifteen minutes to the base of the epiglottis and orifice of the larynx, and continued every hour until the œdema subsides. In the cases recorded by the author, each application was followed by abundant expectoration of adhesive mucus, and an early subsidence of the œdema.

Erysipelatous Laryngitis.

This is an extremely dangerous affection, frequently seen in hospital practice when erysipelas has been prevalent. It may occur from direct extension of erysipelas of the face to the fauces, and thence to the larynx; but there is another form of the same disease, in which the fauces and larynx are first affected, and in which death may take place without the appearance of external erysipelas. In such cases the disease is ushered in with the usual symptoms of erysipelas (rigors, fever, &c.), followed by sore throat, redness and swelling of the fauces, dysphagia, and frequently pain and tenderness about the larynx; hoarseness of the voice and urgent dyspnœa soon come on. These symptoms are occasionally relieved by the appearance of erysipelas externally; but more often the patient sinks into a typhoid state, and dies either from suffocation or exhaustion.

The post-mortem appearances show the usual effects of phlegmonous erysipelas. The mucous membrane of the epiglottis, larynx, and trachea, is much inflamed and œdematous, so that the glottis is narrowed; but the œdema does not extend below the true vocal cords. In most cases the mucous membrane is in parts of a dirty greenish colour, and the cellular membrane beneath in a sloughy condition. Surrounding the glottis, large sloughs of cellular tissue and small collections of pus are occasionally seen. The mucous membrane of the fauces is reddened; and that covering the base of the tongue and tonsils often presents extensive breaches of surface, the result of sloughing.

This disease is of so formidable a character that few patients recover from it; and such a result might be expected, when we consider how seriously a deficiency in respiration must affect those already debilitated by erysipelas. It becomes, then, a matter of great moment to watch narrowly in all cases of erysipelas about the face for the first manifestation of laryngitis. The post-mortem lesions clearly show that this affection partakes of the ordinary characters of erysipelatous inflammation, so that all active depleting treatment must be avoided. When symptoms appear indicating that erysipelas has extended to the fauces, it is our duty to arrest it speedily, before the larynx becomes affected. An emetic should be given, the bowels should be freely relieved, and a blister should be applied to the back of the neck or upper part of the chest. Scarification of the tonsils, fauces, and epiglottis, repeated at intervals of a few hours, is occasionally followed by considerable relief; and the inhalation of the steam of hot water is frequently found a very soothing remedy. Some Surgeons recommend the fauces, pharynx, and upper part of the larynx to be mopped with a strong solution of nitrate of silver. The administration of internal remedies must be modified according to the constitution of the patient; if the disease is recent, and there is much complaint of pain in the neighbourhood of the larynx, the skin hot, and the pulse not indicating great feebleness, salines with small doses of tartar emetic may be given; but in the cases usually seen in London practice no lowering measures can with safety be adopted, and the patient will require wine and brandy, quinine or other tonics, and a generous diet. If urgent dyspnœa supervene, laryngotomy may be performed; and if the operation is determined on, no time should be lost in performing it. In these cases it is seldom of permanent benefit, but life may be prolonged by it, if only for a short time, and the last few hours rendered less distressing by relieving the more urgent symptoms.

Diffuse Inflammation of the Cellular Tissue of the Larynx.

This is a very formidable and fortunately a rare affection. It closely corresponds to diffuse inflammation in other parts, and complicated as it so frequently is with similar inflammation of the whole of the cellular tissue of the neck, might be considered as only part of a more general affection, did not the symptoms in the onset point to the larynx, or the parts in its immediate neighbourhood, as the seat in which it originates. In this disease the free surface of the mucous membrane is unaffected, the obstruction to respiration arising from infiltration of the submucous cellular tissue of the larynx with lymph or pus; sometimes the effused products surround the larynx, trachea, and œsophagus, infiltrate the whole of the cellular tissue of the neck, and extend down into one or both mediastina. The history of this affection is as follows: the patient for some days feels unwell, complains of headache and depression of spirits, soon followed by rigors, soreness of the throat, and symptoms of fever. The fever increases, a sensation of weight and oppression at the chest is complained of, there is much dyspnœa and slight hacking cough, with expectoration of a little white glairy mucus. The soreness of the throat increases, there is great difficulty in swallowing, the fauces and tonsils are swollen, of a dusky red colour, and sometimes ulcerated. One or both sides of the throat become painful, and the glands in the neighbourhood of the jaw so enlarged that it is sometimes with difficulty that the mouth is opened. Occasionally there is a constant and copious discharge of saliva. As the disease proceeds, the neck becomes greatly swollen, the breathing more oppressed, and the dysphagia complete; the fever assumes a low typhoid type, and the patient gradually sinks; but more frequently the breathing is at last so much obstructed that he dies asphyxiated, or he may be carried off at an earlier period of the disease in a sudden paroxysm of dyspnœa. Three cases of this disease have occurred in St. George's Hospital during the last few years; in two death occurred on the fourth and fifth day, in the third case not until the eighteenth day. After death, besides the appearances already described of inflammatory œdema underneath the mucous membrane of the larynx and stopping at the true vocal cords, much effused lymph was found in the cellular tissue of the neck. Sometimes the effusion is limited to one side, or the whole of the front of the neck may be involved, the inflammatory products surrounding the larynx, trachea, and œsophagus extending upwards behind the pharynx, and downwards into the mediastina. Occasionally the cellular membrane of the neck becomes sloughy, putrid, and infiltrated with pus.

In the early stage of this affection it is a matter of extreme difficulty to determine its true nature; but the dyspnœa and dysphagia which soon show themselves, together with the coincident inflammation of the neck, soon lead to a correct diagnosis. The early treatment of these cases should be the same as that above recommended for the laryngitis which occurs in cutaneous erysipelas. If much pain in the throat is complained of, leeches should be applied externally, and warm fomentations constantly used; and if the swelling increases, becomes brawny or tense, and especially if fluctuation is present, deep and free incisions should be made. If the inflammation, as is sometimes the case, happens to be limited, and suppuration not diffused, great relief may be afforded by this mode of treatment. With regard to the operation of laryngotomy in these cases, Mr. Porter observes: "In all these cases of diffuse inflammation (and erysipelas bears a strong similitude to them) operation of any kind seems to be nearly valueless, and death to be almost inevitable. The difficulty of breathing, however apparently severe, is only a secondary consideration; and even if removed, the patient would perish nevertheless of that low and typhoid fever which always attends these affections."

SYPHILITIC ULCERATION OF THE LARYNX.

The larynx not unfrequently becomes affected in those whose health has been shattered by syphilitic disease and intemperance, or where large quantities of mercury have been administered for syphilis in persons of languid and debilitated constitution. This affection most frequently follows one of the various forms of ulceration which occur in the fauces. Thus a sloughing ulcer may invade both tonsils, which rapidly extends, all the neighbouring sound parts becoming successively involved; and this is soon followed by acute œdema of the glottis and death. Or a more chronic form of ulceration may have affected the whole of the pharynx and back of the fauces, and here the local symptoms are of a milder character, the patient complaining of little more than an uneasy sensation in the part during the act of swallowing, not amounting to pain; the constitutional symptoms are, however, very characteristic, the countenance is wan and haggard, there is great debility and emaciation, loss of appetite, and want of sleep, which, together with the history of the case and the presence probably of some cutaneous eruption, indicate the true nature of the disease. In such a case, as soon as the ulceration attacks the larynx, the voice becomes reduced to a whisper, and every attempt to speak is accompanied by a suffocating cough. The breathing also is affected: expiration is comparatively easy, but inspiration is protracted and attended with a peculiar wheezing or rattling noise. Pain is complained of in swallowing solid food, and the attempt to swallow fluids is followed by great pain and suffocative spasms, owing to the insufficient closure of the glottis. There is tenderness or pain in the region of the larynx, sometimes so circumscribed that it becomes possible to diagnose not only which parts of the larynx, but even which side is the seat of ulceration. Most of the above symptoms are constant, but they vary in intensity at different times, and their severity in different individuals is not in proportion to the extent of the ulceration. Not unfrequently the disease is fatal from a sudden attack of œdema of the glottis; or the cartilages may become necrosed, and surrounded with pus, the pressure of which may occasion fatal dyspnœa; or sudden spasm of the muscles of the glottis may ensue at any moment, in which the patient may die suffocated.

The parts surrounding the upper aperture of the larynx are those most frequently found affected after death; and this is what might be expected, as the disease spreads by continuity from the pharynx. The lingual surface of the epiglottis may present a ragged irregular ulcer, or the whole cartilage may be completely destroyed. The ulcerations in the larynx vary in size from a bean or almond to the diameter of an inch or more. Sometimes ulceration lays bare the cornua of the os hyoides and thyroid cartilage, which project into the pharynx. The arytænoid cartilages and the tissues surrounding them are also often affected.

The treatment of this affection must depend on the symptoms and general condition of the patient. If the disease occurs in a constitution not debilitated, and where an imperfect course of mercury has been given for the primary venereal symptoms, the gentle introduction of this drug into the system, so as to produce slight sponginess of the gums, is often of the greatest service. Sometimes the local abstraction of blood by leeches, frequently repeated, affords considerable relief; and in nearly all cases counter-irritation, applied in the form of a blister to the nape of the neck or upper part of the chest, is attended, after frequent repetition, with marked benefit. In by far the larger proportion of cases, however, the active exhibition of mercury is likely to prove highly injurious, the constitution being so shattered that no depleting measures can be borne. Tonics should then be given, such as sarsaparilla or bark, with the iodide of potassium or bichloride of mercury. In all cases it is necessary to support the patient's strength by nourishing diet, and perfect rest of the organ should be enjoined. The daily local application of a strong solution of the nitrate of silver to the upper part of the larynx is sometimes of great service in diminishing the excessive irritability produced by the ulcerated surface; or the inhalation of the vapour of a strong infusion of conium or opium may be tried. If threatening of suffocation should at any time be present, either from acute œdema or spasm, or the pressure of an abscess, laryngotomy should be performed without delay. Many cases of syphilitic disease of the larynx are on record in which life has been preserved by laryngotomy or tracheotomy, and respiration has been performed for many years through the canula.*

Tumours of the Larynx.

Morbid growths of various kinds are occasionally found connected with the tissues of the larynx; but the symptoms caused by such tumours are so similar to those of chronic diseases of the larynx, that their naturo is seldom detected during life. I have found forty-eight such cases upon record.* As to the nature of the growths, what are described as polypi (a most indefinite term) were the most frequent; then warty growths from the mucous membrane; and more rarely, fibrous, fibro-cellular, fatty, osseo-cartilaginous, and malignant tumours. A hydatid also in one of the ventricles of the larynx has been known to project so far into the cavity as to produce the symptoms of a foreign body. The form and size of these tumours are very variable; and in situation they vary also, but by far the greater number are attached to a limited part of the larynx *above* the glottis, generally in the immediate neighbourhood of the vocal cords, more rarely at the side or base of the epiglottis.

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* See Hilton in *Lancet*, vol. ii. 1853, p. 57.

The general symptoms produced by these growths so nearly resemble those of chronic diseases of the larynx, that, in order to avoid repetition, the reader must be referred to that section. The intensity and prominence of individual symptoms will depend on the size and situation of the tumour. Thus, the nearer the tumour is situated to the vocal cords, the more will the voice be interfered with. Respiration is always affected, being sometimes attended with a peculiar wheezing; at other times there are occasional attacks of severe dyspnœa, with intervals of complete ease. In nearly all cases the dyspnœa, though slight at first, steadily increases, and is soon followed by suffocative attacks. The symptoms are not equally well marked in every case, nor are they all invariably present; the most constant symptoms are alteration of the voice and dyspnœa. Unfortunately there are seldom any characteristic signs by which the presence of a tumour can be detected. In a case of fatty pendulous tumour of the pharynx and larynx recorded by Mr. Holt in the 5th volume of the *Pathological Transactions*, the presence of a tumour was certain, from the fact of the patient, four years before his death, during the act of vomiting, protruding a large mass, which he was obliged to return as speedily as possible to prevent immediate suffocation. In a case recorded by Dr. Hawkesley in the 8th volume of tho samo Transactions, the presence of certain characteristic cell-forms in the sputa, together with enlargement of the lymphatic glands in the neighbourhood of the larynx, appeared to have led to the conclusion, prior to death, that the affection was of a malignant nature; and it sometimes happens that portions of the tumour are ejected with the expectoration; this has occurred in three cases, affording in each the most certain sign of the presence of a tumour. In a case related by Otto, the patient ejected masses of the tumour on three different occasions; and it was this circumstance in the case related by Ehrmann that led him to perform an operation for the removal of the growth. Sometimes the tumour may be *seen*, and occasionally it can be *felt*, on examining the larynx; so that in all cases in which such a growth is suspected, the larynx should be narrowly examined by the laryngoscope and by the finger. Dr. Horace Green has in two cases been able to detect by sight the presence of a polypus in the larynx, in one of which the growth was successfully removed; and M. Roux detected the presence of a growth by introducing the finger into the mouth of the patient. Sometimes, indeed, the tumour may be *heard* or *felt to move* in the larynx; in the case successfully operated upon by Ehrmann, the patient was able to imitate the sound of a valve opening and shutting by a rapid movement of inspiration and expiration.

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* Namely, 31 by Ehrmann; 8 by Dr. Horace Green; 1 by Dr. Watson; 6 in the *Path. Soc. Trans.*; 1 in the *Med.-Chir. Trans.*; and 1 in the records of St. George's Hospital.

Warty growths from the mucous membrane of the larynx generally assume the form of small branched excrescences, consisting mainly of epithelium and a little fibrinous and granular matter. They usually arise from the vocal cords on one or both sides, and sometimes smaller excrescences are met with, springing from the neighbouring mucous membrane and from the root of the epiglottis. These excrescences form one or more large pedunculated masses, which fill up the upper part of the larynx, and almost completely close the rima. The affection would appear at times to be congenital, for cases of it are recorded in which dyspnœa had existed from birth. Death is generally sudden, and takes place during an attack of spasmodic dyspnœa. The frequency of the affection at an early period of life, the length of time during which the symptoms have existed, the total failure of all remedies, and the absence of many of the signs peculiar to other affections of the larynx, may lead to the formation of a correct diagnosis. Deglutition is seldom interfered with.

All medicinal remedies have been found useless. The only way in which life can be prolonged is by opening the air-passage. If this operation is resorted to, the patient may probably live for several years, breathing through a tube. Ryland records an instance of this disease in which laryngotomy was performed; the thyroid cartilage being then divided from top to bottom, the larynx was found full of warty excrescences; they were cauterised with the nitrate of mercury, and afterwards with a hot iron, but they continued to grow. The result of the case is not mentioned.

In a case recorded by Professor Ehrmann, a woman aged thirty-three, who suffered from all the symptoms of a tumour within the larynx, was seized with a fit of almost fatal suffocation; tracheotomy was performed, and on the following day the incision was extended upwards through the junction of the alæ of the thyroid cartilage, and a cauliflower excrescence removed from the left vocal cord. The patient recovered, with loss of voice. Seven months after, the woman having died of typhoid fever, the tumour was found just commencing to sprout again.

In a third case, which came under the care of Dr. Horace Green, the passage of a small sponge probang saturated with a solution of nitrate of silver, and passed through the glottis at certain intervals, detached the growths and effected a complete cure.

A few cases have been recorded of pendulous tumours growing from the pharynx and larynx, and interfering with the function of both these parts. In Mr. Holt's case, a large pendulous fatty tumour was detected filling the pharynx, and reaching down the œsophagus to the extent of nine inches, attached by an envelope of mucous membrane and fibrous tissue to the left side of the epiglottis, dragging it down and to the left side, so as entirely to prevent perfect closure of the larynx; and in Dr. Arrowsmith's case, a freely movable lobulated tumour, about the size of a walnut and of cellular texture, was discovered hanging by a narrow pedicle from the commencement of the œsophagus immediately behind the glottis.* This tumour not only obstructed the œsophagus, but, by passing under the epiglottis during attempts to swallow, prevented the closure of the glottis, and thus allowed fluids to pass into the trachea. The main symptoms in both of these cases were at first an occasional and then increasing sensation of choking, difficulty of deglutition, gradually becoming more severe, and each attempt accompanied by much spasm of the glottis and great dyspnœa, frequent and at times severe cough excited by attempts to swallow, with copious frothy expectoration, and occasional huskiness of the voice. In Dr. Arrowsmith's case death occurred from inanition; and in Mr. Holt's from displacement of the growth, by which suffocation was induced. The diagnosis in such cases may be assisted by careful examination of the back of the throat; the mouth should be widely opened, the tongue drawn well forwards, and the index finger passed behind the epiglottis sufficiently far to ascertain the presence of a polypus.

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* *Med.-Chir. Trans.* vol. xxx.

Treatment. If the existence of a tumour is detected, surgical aid is imperatively demanded, to avoid impending suffocation from displacement of the tumour, and to prevent death from inanition. When the tumour is attached to the sides of the epiglottis or back of the larynx, it may be removed by the knife or scissors,* or a ligature may be passed round its base; but before its removal is attempted, the propriety of securing free respiration by opening the windpipe should be considered. When the tumour arises *within* the larynx, both the diagnosis and treatment present more difficulty. If, however, the Surgeon is fortunate enough to satisfy himself without doubt of the existence of a tumour in this locality, its removal may be attempted by freely laying open the cavity of the larynx. The operation is doubtless a hazardous one; but as long as the tumour remains, the patient is in constant danger of death from suffocation. When the larynx is affected with malignant disease, in which case the parts in the neighbourhood are usually infiltrated and the neighbouring glands affected (which circumstances, together with the character of the sputa and the constitutional cachexia, will assist the Surgeon to form a diagnosis), tracheotomy is justifiable in order to prolong life. Mr. Curling† performed this operation in a case of epithelioma of the larynx, where the patient lived for a year afterwards, and the relief for a time was very striking; and Mr. Ward‡ adopted the same course in a similar case with marked benefit.

HYSTERICAL AFFECTIONS OF THE LARYNX.

There are certain affections of the larynx not unfrequently met with in hysterical subjects, the symptoms of which require to be mentioned, as they are liable to be mistaken for those of more grave diseases. In the first of these the muscles of the larynx are highly irritable, and present a constant disposition to spasms. A violent paroxysm of dyspnœa comes on suddenly, or it may be preceded by a long-continued and convulsive cough, and followed by the stridulous breathing peculiar to inflammation of the larynx, the dyspnœa being so severe as to threaten suffocation. Such a paroxysm may continue for two or three hours, and occasionally terminates in an ordinary hysterical fit. This affection is not uncommon in young hysterical females, and the dyspnœa which attends the attacks is so alarming, that tracheotomy has not unfrequently been performed for its relief, from the supposition that the symptoms depended on inflammation. An interesting case of this kind has been recorded by Dr. Watson.* Another case is related by Ryland, in which danger from suffocation seemed imminent, and the operation was commenced; but before it could be completed, all signs of obstructed respiration disappeared.

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* This operation was successfully performed by M. Laugier, *Hist. des Polypes du Larynx*, 1850.

† *Path. Soc. Trans.* vol. ix. p. 39.

‡ Ibid. vol. x. p. 63.

The peculiar paroxysmal nature of the attacks, the absence of fever and of pain and soreness in the region of the larynx, with a careful attention to the history and progress of the disease, will seldom fail to lead to a correct diagnosis. The general treatment of hysteria should be adopted, and recurrence of the attacks should be prevented by improving the general health, and by the use of remedies calculated to correct any disorder of the menstrual function.

Another affection of the larynx, which not unfrequently occurs in hysterical subjects, consists in deficiency or total loss of nervous power in the muscles of the larynx, which produces temporary loss of voice—aphonia. It occurs most frequently in young hysterical females, is unattended by any symptoms of inflammation or other apparent disease of the larynx, and appears to be dependent on great debility, irregular or disordered menstruation, or excessive exercise of the vocal organs in a debilitated constitution. "This affection," observes Sir Benjamin Brodie,† "takes place suddenly, continues often for many months, even for one or two years, and then disappears as suddenly as it began. A patient thus affected may, when under the influence of strong mental excitement, find herself speaking in her natural voice, when for some time before she had spoken only in a whisper. Her recovery may be permanent, or she may relapse into her former condition." And again this distinguished author observes: "This affection is not unfrequently met with in the male sex, especially in those of the clerical profession, probably because they often lead very sedentary lives, and also because in their profession they are called upon to speak in public in a tone raised above the ordinary standard." This form of aphonia may be distinguished from that resulting from chronic disease of the larynx, by the suddenness of the attack, and the occasional temporary return of the voice under strong mental excitement; by the history of the case, and the absence of pain and other signs of disease.

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* *Lectures on the Principles and Practice of Physic*, vol. i. p. 089.

† *Lectures on certain Local Nervous Affections*, p. 51.

The treatment must be varied according to circumstances. The general health should be attended to, and the functions of any organ that appears deranged should be rectified. Tonics, the shower-bath, and horse exercise, are the constitutional means most likely to be beneficial. Trousseau strongly advocates cauterising the pharynx and upper part of the larynx with a strong solution of the nitrate of silver. Blisters, issues, galvanism, and electricity have each frequently been successful, and as frequently failed to afford any relief.

Spasm of the Glottis.

The Surgeon is occasionally summoned to a patient having all the symptoms of impending suffocation, and is probably told that previous to the attack the patient was perfectly well; that the attack was sudden; and if he is not already moribund, it may have subsided, so that he suffers little or no inconvenience: it may be that the patient has suffered slight occasional paroxysms of dyspnœa for several years, accompanied with cough, pain, and a sense of constriction about the chest, and other symptoms indicating thoracic disease; the present attack being merely an aggravated form of the complaint. If we exclude those affections of the lungs and pleura, the heart and pericardium, in which dyspnœa is a prominent symptom, as well as cases of difficult breathing produced by the presence of abdominal tumour or ascites, we find that dyspnœa, accompanied often by spasm of the muscles of the glottis, may be produced by, 1st, the pressure of tumours upon some part of the respiratory tube; 2d, irritation of the nerves distributed to the larynx; 3d, some source of local irritation in the neighbourhood of this organ, such as foreign bodies, or inflammation, or ulceration of the larynx. The most common forms of intra-thoracic tumours, which produce dyspnœa by compressing the lower part of the trachea and bronchi, are, thoracic aneurisms and enlargement of the bronchial glands from strumous deposit, cancer, or common hypertrophy. Dyspnœa may also arise from enlargement of the cervical lymphatic glands, or from enlargement of the thyroid gland, compressing and displacing the trachea or larynx. Irritation of the trunks or branches of the nerves distributed to the larynx may produce the same symptoms. A few years since, a patient died in St. George's Hospital, who, some days previous to her death suffered from much spasmodic affection of the glottis, produced apparently by effusion of a large mass of lymph around the roots of the eighth pair of nerves at the base of the brain, the larynx being found after death quite healthy. A tumour in the course of the laryngeal nerves may press upon them, and give rise to similar symptoms. Dr. Budd has lately recorded an instance of death from dyspnœa, occasioned by the growth of a cancerous tumour in the groove between the trachea and œsophagus, with probable destruction of the left recurrent nerve;* and instances are by no means uncommon of aneurism of the aorta or innominate artery producing spasm of the glottis, by implicating the recurrent laryngeal nerves where they lie near these vessels. Instances of local irritation in the neighbourhood of the larynx, producing spasm, are seen in some cases where a foreign body is impacted in the upper part of the œsophagus, or where inflammation or abscess exists in the immediate vicinity of the larynx.

It becomes, then, a matter of great importance for the Surgeon to examine narrowly into every case in which he may be called to relieve dyspnœa and impending suffocation. I have known the operation of laryngotomy resorted to, to relieve dyspnœa depending on apparent laryngeal disease, but in which, after death, the larynx was found healthy, and the difficulty of breathing depended on pneumonia. A careful examination of the chest should in every case be made; and if thoracic disease is detected, no surgical interference is of any avail. If it is possible to remove the local cause which produces the spasm, this should at once be done: if an abscess exist, it may be opened; if a foreign body is impacted in the pharynx or œsophagus, it should be removed. If the symptoms arise from the pressure of a tumour irritating the laryngeal nerves, the dyspnœa is probably intermittent. The operation of tracheotomy is justifiable, if even only temporary relief is afforded; but where the tumour is large, and the dyspnœa continuous and produced by its compressing and contracting the air-passage, there is no hope to be entertained from any surgical interference, and no operative measures are justifiable.†

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* *Path. Trans.*, vol. x. p. 62.

† I leave this statement as my late friend wrote it; but he would probably have modified it, had he lived to give the final revision to his manuscript,—so far, at any rate, as to say that when dyspnœa is occasioned by the pressure of an enlarged thyroid body, it is quite justifiable to divide the

Chronic Inflammation of the Larynx.

The symptoms and effects of this disease vary according to the exact seat of the inflammation, its extent, and the constitution of the patient. In some cases the inflammation is slight, the local changes trifling, and the symptoms soon subside. Probably such a mild form of inflammation exists in many of the cases of the aphonia already alluded to as attacking clergymen and other public speakers and singers. In these cases, however, the affection is only a temporary inconvenience, and either subsides spontaneously, or the mildest treatment suffices for its cure. Among certain of the poorer classes, who are much exposed to cold and damp (*e. g.* washerwomen) and indulge immoderately in ardent spirits, and in street-hawkers who are constantly straining the voice, the symptoms are more permanent; there is confirmed hoarseness or great imperfection of the voice, and further local changes and more severe symptoms are liable to occur. But the more severe forms of chronic laryngitis are found in patients who suffer from other affections of the throat, as follicular disease, or whose constitution is shattered by syphilis, by the use of mercury, or by struma. In all these cases the symptoms are slow and very insidious, and the larynx is often irreparably damaged. The patient at first complains of hoarseness and a sense of dryness in the throat, usually referred to cold. Pain and soreness in the region of the larynx, and tenderness on pressure, come on, with short dry cough and mucous expectoration. Then a distressing sense of constriction is experienced at the upper part of the larynx, inspiration becomes difficult and stridulous, the voice is lost, cough is constant and sometimes attended with spasmodic dyspnœa, and soreness of the throat is sometimes complained of, when, on examination, ulceration may be detected about the soft palate, or, by depressing the tongue and drawing it well forwards, at the base of the epiglottis. In protracted cases the patient sinks, under the constant cough and profuse expectoration, into a hectic condition.

The rate of progress of chronic laryngitis varies considerably. In the notes of two cases now before me, I find that the patients

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tumour in order to open the trachea. A remarkable case, in which not only life was preserved, but the enlargement of the thyroid gradually disappeared, is related by Mr. Bryant in his *Clinical Surgery.* See also Diseases of the Thyroid Body. *Editor.*

died within seven weeks from the onset of the symptoms, while in others the disease has lasted for several years. The affection is far more common soon after puberty than either in early life or old age, though hardly any period of life is exempt from it. Thus, of 55 cases in the records of St. George's Hospital, 3 occurred before the age of 16, 34 between 20 and 40 years, 15 between 40 and 60 years, and 3 between 60 and 70 years of age. It is remarkable that all the patients except nine were males.

The local changes produced in the larynx by chronic inflammation are as follows: In the early stages increased vascularity of the mucous membrane, with effusion of lymph in the submucous tissue, are said to be the only recognisable changes. Later on, and especially in the simple form which occurs from exposure to cold or from straining the voice, the lingual surface of the epiglottis and the folds which surround the upper orifice of the larynx are said to become permanently thickened from the organisation of the effused lymph, and their free surface rough and granular. But in most cases, especially in phthisical subjects, ulceration takes place both in the larynx and on the base of the tongue, the fauces, and tonsils; tubercle being also occasionally found beneath the mucous membrane. This ulceration may be extensive or limited, and in the latter case its position serves to explain the symptoms noticed during life. The most common situation of limited ulceration is over the vocal cords. This lesion is found in more than half the cases examined, and accounts for the hoarseness and aphonia so common in these affections. The next most common seat of ulceration is in the cavity of the larynx or on the epiglottis (usually its laryngeal surface); and this is found in rather less than half the number of cases examined. The epiglottis is often rendered so rigid as to be nearly immovable. Ulceration about the fauces and epiglottis causes pain in swallowing, and a tendency for the food to pass into the air-passages. Ulceration is found in the trachea in rather more than a fourth of the cases; while the cartilages of the larynx are affected (*i. e.* either exposed by ulceration, carious, or necrosed) in nearly one-fourth of the cases, the thyroid and arytænoid being those most frequently involved.* Sometimes the ulceration penetrates from the interior of the larynx through the cartilage, and communicates with the cellular tissue of the neck. Ulceration in the cavity of the larynx, or caries and necrosis of the cartilages, is usually associated with great pain, referred to the larynx.*

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* Louis states that out of all cases of phthisis, ulceration of the larynx occurs in about one-fourth.

Diagnosis. Mr. Porter says that it is sometimes difficult to distinguish the milder forms of chronic laryngitis from bronchitis. The latter affection, however, is usually ushered in by febrile symptoms, great oppression of the chest, difficulty in taking a deep breath, and palpitation or other irregular action of the heart. From chronic tonsilitis the affection in question is easily distinguished by examining the fauces, and by the absence of cough and presence of dysphagia in enlargement of the tonsils. In hysterical affections the absence of pain in the larynx, the history of the case, and the general appearance of the patient, will usually lead to a correct diagnosis, which will often be converted into a certainty by the complete return of the voice under excitement. The diagnosis of tumours has been already dwelt on. When the nature of the affection has been decided on, the next point is to ascertain its cause, in order to combat the constitutional cachexia which may be present. The symptoms should also be carefully observed, so that a correct conclusion may be drawn as to the situation and extent of the morbid action, and it should be ascertained whether, and to what extent, the lungs are affected. Cases do occasionally, but very rarely, occur of well-marked strumous ulceration of the larynx not associated with the deposition of tubercle elsewhere.

Treatment. In those cases where the affection arises from exposure to cold, and is probably limited to inflammatory thickening of the membrane, inflammation should be arrested and absorption promoted. The larynx should be kept at perfect rest, strict silence should be enjoined, counter-irritation at the nape of the neck or upper part of the chest may be used, and mercury in small doses should be administered. As a local remedy, the inhalation of the steam of hot water is of great service. These remedies seldom fail to afford complete relief if the disease is not neglected, and the voice becomes perfectly restored if no alteration of structure has taken place in the mucous membrane. In chronic laryngitis occurring as a result of the venereal poison, or from the exhibition of mercury, the treatment should be guided by the principles already mentioned. In ulceration of the larynx occurring in cachectic constitutions, as a sequel of continued fever, or in connexion with phthisis, tonics should be administered, a generous diet allowed, with change of air, the organ being kept at perfect rest, and local pain may be relieved either by the inhalation of sedative vapours or by the application of some counter-irritant. In most forms of chronic laryngitis, the topical application of a solution of the nitrate of silver is considered to be almost a specific. The application of this remedy to the immediate neighbourhood of the ulcerated surface doubtless relieves the excessive irritation, and tends to accelerate the cicatrisation of the ulcer. This practice has been strongly advocated by Trousseau, Horace Green, and J. Warren, and was employed many years previously by our own countryman Sir C. Bell. The strength of the solution should vary from half a drachm to a drachm of the salt in an ounce of distilled water. Its mode of application consists in depressing the tongue with the finger, and then passing a sponge probang, previously saturated with the solution, into the fauces and upper part of the larynx. In commencing this treatment, it is well in the first instance to apply the solution freely to the soft palate, fauces, root of the tongue, and epiglottis, having previously removed with a piece of dry lint or sponge the viscid mucus, which in these cases accumulates in considerable quantity, and prevents the solution from coming in direct contact with the mucous surface.* This plan of treatment should be adopted daily, or every second day, with occasional intermissions, and will probably be followed by considerable benefit. Some Surgeons prefer introducing the caustic solution by means of the *laryngeal syringe*, on account of the irritation likely to be produced by the pressure of the sponge, and on account also of the greater certainty and ease with which the application may be effected. During this treatment the larynx should be kept at perfect rest, strict silence being enjoined; any tendency to spasm may be relieved by the exhibition of an anodyne or sedative inhalation; tonics are generally necessary, and a generous diet should be allowed.

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* Ulceration of the trachea sometimes occurs from the pressure and irritation of diseased glands in its neighbourhood. A case will be found reported by Dr. J. W. Ogle in the *Path. Soc. Trans.*, 1856-7, p. 99; and another of a somewhat different character by Dr. Tice in the 26th vol. of the *Med.-Chir. Trans.* More than one has recently occurred at St. George's Hospital. The consideration, however, of this somewhat rare affection more properly belongs to the physician. Here it will be enough to say that the symptoms resemble those of croup to a certain extent, but there is no inflammatory fever. It will be remembered that a bronchial gland sloughing into the trachea has been known to act the part of a foreign body (see vol. ii. p. 300).

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* Much difference of opinion exists as to whether, or to what extent, a sponge probang can be passed into the cavity of the larynx; some practitioners asserting confidently the impossibility of gaining this cavity, and others maintaining the practicability not only of entering the cavity, but also of passing the instrument through the glottis into the trachea and bronchi. It is well known that both in this country and in America it is commonly stated by the advocates of this treatment that a sponge probang can be easily passed into the cavity of the larynx, and through the glottis into the trachea, and they professedly adopt this mode of treatment in numerous cases; but a careful examination of the subject leads me to believe that in the great majority of cases this is quite impracticable. In numerous instances in which I have seen the sponge probang used by those daily employing it, I believe that the instrument never entered the larynx, but was passed through the pharynx into the œsophagus, and the slight impediment to its passage usually attributed to spasm of the muscles acting on the vocal cords, is produced by the contraction of the lower end of the pharyngeal muscles,—a sensation always experienced on

It may be asked, is tracheotomy likely to afford relief in these cases, and under what circumstances should the operation be performed? During the progress of the disease, if an attack of spasm should occur so severe that danger of suffocation is imminent, tracheotomy is justifiable. Again, also, if the symptoms are not relieved by the treatment above mentioned, but the patient continues to suffer from urgent dyspnœa, with occasional paroxysms of spasm, a troublesome cough, and purulent expectoration, tracheotomy may be performed with the view of placing the organ in a

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passing a bougie into the œsophagus. When we consider the peculiar position of the larynx, its liability to spasm on the slightest touch of any foreign substance, and the dyspnœa that must ensue on the introduction of such an instrument, and its retention in the air-passages only for a few seconds, the almost total absence of the latter symptoms in the cases I have witnessed, when the probang was used, leads me to believe that in the great majority of cases this is never accomplished. On the dead subject it is a matter of no slight difficulty to pass an instrument into or through the larynx; and I have seen those who professedly adopt this practice in the treatment of laryngeal disease fail in nearly every instance in which the attempt was made. The fallacy of this practice is shown in the results of similar experiments conducted by the New York Academy Commission, in which the sponge probang failed to pass in every case in which it was tried. Some patients manifest much less sensibility in these parts, and in some the natural conformation of the fauces and larynx is such that they can be more freely exposed and examined. In such instances, by caution and gentleness, and employing a probang with a large curve, the sponge may be introduced into the upper part of the cavity of the larynx. The sensations produced, however, under these circumstances will not leave much doubt, either in the mind of the Surgeon or in that of the patient, that the larynx has been reached, and any attempt to prolong the application by trying to pass the instrument beyond the vocal cords will be attended with such manifest symptoms of suffocation as to compel the Surgeon to withdraw the instrument.

state of perfect repose, and relieving the patient from the dyspnœa and attacks of spasm from which he is constantly suffering. The operation affords considerable relief, and such remedies may afterwards be adopted as may lead to the cicatrisation of the ulcerated surfaces. If life by this means is only prolonged, the freedom from suffering is alone a great advantage; but recovery may occur, though imperfect, the patient continuing to breathe through a canula for the rest of life; and where the larynx is not so impaired by structural changes as to interfere with respiration, complete recovery may ensue, especially if the operation has been resorted to at an early period.

If chronic laryngitis continues long unrelieved, symptoms may arise analogous to those of pulmonary hectic; and this disease is called phthisis laryngea. It is well known, that after a certain period of life the cartilages of the larynx become converted into bone, the change being accompanied with no inconvenience. But in particular constitutions, and as a result probably of long-continued inflammatory action, this change occurs at an earlier period of life; and is frequently followed by caries, separation of the perichondrium, necrosis, and the formation of abscess, which produce a distressing and dangerous train of symptoms. The symptoms of this disease are very insidious; its approach is gradual and its progress slow. At first it resembles chronic laryngitis. If the symptoms are unrelieved, the difficulty of breathing becomes distressing, so much so that there is constant danger of suffocation, when suddenly considerable relief is experienced on the expectoration of a large quantity of dark fœtid pus, in which may probably be found small gritty particles of earthy substance, or a portion of disorganised cartilage. As the disease proceeds, the cough is incessant, the expectoration profuse and very fœtid; dyspnœa is constant, and frequently aggravated by attacks of spasm; the lungs become affected, the health gradually gives way, and the patient sinks, with all the symptoms of hectic.

This form of laryngeal disease not unfrequently accompanies pulmonary phthisis; in other cases it would appear that the larynx is the part first affected, the lungs becoming diseased subsequently. This disease may prove fatal in various ways. One of the arytænoid cartilages, becoming partially detached by ulceration, may be displaced, and suffocation ensue. Abscess may form in the neighbourhood of one of the cartilages, which, from its pressure or the spasm which it induces, may produce fatal asphyxia. Suffocation may arise from œdema of the glottis, caused by the irritation of the necrosed cartilage; or the constant cough and excessive purulent expectoration may induce slow hectic, in which the patient finally sinks.

There is another form of disease of the cartilages, in which mortification takes place as the result of inflammation, the cartilages being found after death soft, of a yellowish waxy appearance, or black and like a piece of wet and rotten leather, the affected cartilage lying loose in the cavity of an abscess formed between it and the soft parts around. This form of disease is much less frequent than the preceding; its symptoms are similar, but run a very rapid and fatal course, and ossification does not precede the death of the cartilage.

In these diseases the organ should be kept at perfect rest, and the use of the voice strictly prohibited; cough should be alleviated by proper medicines, and local pain be relieved by counter-irritants. If the epiglottis is partially or entirely destroyed, rendering deglutition difficult or impossible, the patient should be fed with an œsophagus tube, and attacks of spasm should be palliated by narcotics. If these remedies fail, and the patient is in danger of death from suffocation, laryngotomy should be performed; this frees the patient from the distressing effects of spasm, and holds out some promise of ultimate relief; for the necrosed cartilage, especially if it be the arytænoid, may be expelled by coughing, and the symptoms may cease; but in most cases the structure of the larynx is so impaired that respiration can never be perfectly performed, so that the patient must continue to breathe through the canula for the rest of his life.* As it is obvious that a complete cure can only result from the removal of the whole of the diseased cartilage, if any portion of it can be found to be dead and loose, it should be at once removed. In the museum of St. George's Hospital are three portions of thyroid cartilage, which were removed by Mr. Cæsar Hawkins from the larynx of a man who some time previously had attempted suicide by cutting his throat with a razor; the wound had entirely healed, with the exception of a fistulous opening leading down to the thyroid cartilage, which was exposed, and in time necrosed, and finally separated. The portions were removed, the wound healed, and the patient was discharged cured.

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* These diseased cartilages sometimes exfoliate into the air-passage, and act the part of foreign bodies. A case was related to the Medico-Chirurgical Society by Mr. E. Humby, in which Mr. Liston had opened the trachea for dyspnœa, depending on syphilitic disease of the larynx. A necrosed portion of the cricoid cartilage was ejected from the wound during life, and another was found in the bronchus after death.

HENRY GRAY.

The following essay, on the Laryngoscope, must be read in connexion with this. Mr. Gray's sudden death prevented the final revision of his Ms.; and in particular the parts relating to the method and uses of laryngoscopy were left in a fragmentary condition. The Editor has revised the rest of the treatise; but it was thought better to erase all that referred to the use of the laryngoscope in the diagnosis of tumours and chronic diseases of the larynx, and to make that the subject of a separate essay, which must be considered as an appendix to the preceding. *Editor.*

THE LARYNGOSCOPE.

THE ordinary symptoms of laryngeal disease, such as pain, difficulty of respiration and deglutition, alteration of the voice, &c., frequently fail to indicate the precise nature of the malady; and some additional aid to diagnosis must be obtained, or the treatment adopted is likely to be as unsuccessful in result as it is necessarily uncertain in direction. Such additional aid is afforded by the Laryngoscope; an instrument suggested many years ago, but only very recently urged upon the general attention of the Profession.

Liston, writing in 1840, was the first to state definitely that a view of the interior of the larynx in the living subject might be obtained by means of a speculum "introduced with its reflecting surface downwards and carried well into the fauces."* A few years later, Mr. Avery contrived a laryngoscope similar in principle to those now in vogue, but somewhat more complicated in construction, and perhaps more difficult to manage.† Mr. Avery made extensive practical use of this instrument, and affirmed that with it he had been able, under favourable circumstances, to see as far down the air-passage as the bifurcation of the trachea. In 1855 Garcia published an account of numerous laryngoscopical observations made upon himself for the purpose of ascertaining the mode of formation of the voice. He employed two mirrors. One furnished with a long and suitably curved stem, he introduced into his pharynx, and illuminated by sunlight reflected from the other, duly arranged in front of him. The image of the larynx formed in the first mirror was transmitted to the second, and there observed.‡ The results obtained by Garcia have been for the most part confirmed by recent investigations. In 1857 Doctor Türck of Vienna commenced a series of experiments relative to the construction of the laryngoscope, and its use as an aid to diagnosis.* Shortly afterwards, Dr. Czermak of Pesth took up the subject.† He very much facilitated research by adopting artificial light for the illumination of his mirrors. Previous observers, with the exception of Mr. Avery (who used a lamp with a perforated reflector), depended on direct sunlight; their observations, therefore, could only be made in convenient places, at certain hours, and in favourable weather. To Türck and to Czermak we are deeply indebted for the perseverance and skill with which they have pursued their observations and experiments, and for the wide-spread publication of their results. We grant to neither the claim to priority, which each asserts, but we willingly accord to both the full merit of having done far more than any of their predecessors to improve the construction of the instrument, and teach the method of its use. During the last two or three years, the subject has been diligently studied by Türck, Czermak, and others, and enough has been already accomplished to justify the belief that laryngoscopy, though at present richer in promise than in result, will nevertheless ultimately prove of very great value, both to the scientific physiologist and the practical Surgeon. Many inventions and discoveries of the highest importance have at the first been coldly received, or even inconsiderately condemned. Such, to a certain extent, has been, nay is, the case with the laryngoscope. We must ever remember, however, that it is far easier to decry a new method of investigation than to become familiar with its application;—far easier to speak slightingly of a new intrument than to acquire dexterity in its use. Laryngoscopical examinations, to be successful, always demand patience and skill on the part of the operator, and frequently also considerable self-control, and some practice on the part of the patient. Numerous difficulties arising from various sources are liable to occur; but in almost all cases they may be overcome by perseverance, and satisfactory results obtained.

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* *Practical Surgery*, 1840, p. 417.

† Vide *Lancet*, June 16th, 1860. Mr. Avery's laryngoscope has been courteously shown to me by Messrs. Weiss, Strand, as well as the modern instruments which they supply.

‡ *Philosophical Magazine*, vol. x. p. 218.

The laryngoscope essentially consists of the laryngeal speculum, and some contrivance by means of which a good light can be thrown into the pharynx.

The laryngeal speculum is a small plane mirror, fixed to the extremity of a thin but strong stem, of sufficient length, furnished with a fixed or movable handle. The mirror may be of polished steel, speculum metal, or silver; or of looking-glass mounted in a thin metal frame. It may be circular, elliptical, ovate, or quadrilateral with rounded angles. The three first-named forms, to be used according to circumstances, are recommended by Türck;[*] the last by Czermak.[†] For all ordinary examinations, the circular and quadrilateral forms appear to me to be the best, and to answer equally well. In cases, however, in which it is necessary to carry the speculum very deeply into the pharynx, the elliptical or the ovate form is preferable. The mirrors vary from half an inch to an inch or more in diameter. In every case, the larger the mirror that can be employed, the better is the view obtained. The stem may be straight or slightly curved. It is fixed in the quadrilateral speculum to one angle; in the ovate, to the broad end; and in the circular, to any part of the circumference. The diameter of the mirror drawn to the point of junction should form with the stem an angle of from 120° to 125°; and further, the mirror should be so inclined as to look slightly downwards when the stem is held horizontally. Want of attention to these points in the construction of the instrument renders it difficult to manage.

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* *Zeitsch. der Ges. der Aerzte*, no. 17.

† *Gazette hebdom. de Vienne*, no. 13.

For the illumination of the speculum, when in position, the direct light of the sun answers perfectly, but is seldom available; some other source of light *must* frequently and *may* always be employed. Türck at one time recommended the use of a lamp, and a glass globe filled with water, so arranged behind the operator that the rays from the lamp, concentrated by the globe, passed over his shoulder into the pharynx of the patient seated opposite with widely open mouth.[‡] Türck has since discarded this plan in ordinary examinations, but still adopts it when sponging the larynx with caustic or other solutions.[§] The light of a lamp, concentrated by a very large concave mirror (both lamp and mirror being placed behind the observer), has been tried by Störk.[‖] Moura-Bourouillou, in a recent publication,[¶] has strongly recommended an instrument which he calls the "Pharyngoscope." This consists of a large biconvex lens capable of bringing to a short focus the light of a powerful lamp, to the stand of which it is so connected as to be easily adjusted, and moved in various directions. The whole apparatus is placed between the operator and the patient, and the view taken on one or other side of it. The disadvantages of this arrangement, in examinations made upon another, are obvious. For auto-laryngoscopy, however, the pharyngoscope answers very well, when a large plane mirror perforated in the middle is fitted round the lens. Messrs. Marratt and Short (of King William Street, London Bridge) have lately made, at my suggestion, a modification of an ordinary magic lantern, in which the lenses are arranged to bring the light to a focus about two or three feet from the extremity of the tube. This apparatus is very useful as a means of illumination in all speculum examinations. It stands behind the observer, and for laryngoscopy is so placed that the light passes over his shoulder. The head of the patient is moved into proper position. The advantages afforded are great. The face of the operator is unhampered, his head is free to move, the equal use of both eyes is permitted him, and the space between himself and his patient is entirely unoccupied. For consulting-room practice nothing could be better; unfortunately, the lantern is rather expensive and not very portable. Czermak was the first to use a modification of the ophthalmoscope as a means of illumination in laryngoscopy;* and some such method as is described in his earliest publications on the subject is in most cases more readily applicable,—at any rate, is at present more generally adopted,—than any other hitherto suggested. According to such method, a good moderator or other lamp is placed close to one side of, and slightly behind the head of the patient, who is seated near the corner of a table. The light is duly reflected by a concave mirror immediately in front of the operator's face. This mirror should be circular in outline, three or four inches in diameter, and should have a focal distance of from eight to twelve inches. It may be placed before one eye, the observer looking through a small perforation in, or near the centre; or it may be unperforated, and placed between the eyes, and in front of the forehead, the observer looking on either side of, and below it. It may be held in the hand when the hand is not required for other purposes. It may be connected with a stand, in such a manner as to be freely movable in all directions; this is by far the most convenient and agreeable arrangement. It may be attached to the head of the operator by an ordinary spectacle-frame, a frontal band,* or a spring passing over the vertex; or it may be fixed in a wooden handle, to be held between the teeth. The last-named plan is recommended and practised by Czermak; but it appears to me awkward and unpleasant. The general arrangement should be such that the lamp, the mouth of the patient, and the eye of the observer, with the reflecting mirror before it, are as nearly as possible in the same plane. If the laryngeal speculum is held in the right hand of the operator, the lamp should be placed on the right side of the patient, and *vice versâ.* If, as is sometimes convenient, the lamp is placed above and behind the head of the patient, the vertical plane must be preserved; but the speculum may be held with equal advantage in either hand, without risk of obstructing the light.

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[*] *Méthode pratique de Laryngoscopie*, par le Docteur Türck. Paris, 1861, pp. 16-20.

[†] *Du Laryngoscope*, par le Docteur Czermak. Paris, 1860, p. 18.

[‡] Türck, *Zeitschr. der Ges. der Aerzte*, no. 26, 1858.

[§] Türck, *Méthode pratique*, pp. 95, 96.

[‖] *Zeitschr. der Ges. der Aerzte*, no. 46, 1859.

[¶] *Cours complet de Laryngoscopie*, Paris, 1861.

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* *Gazette hebdom. de Vienne*, no. 13, and op. cit.

The patient to be examined should, if possible, be seated, his body leaning somewhat forward, his head inclined slightly backwards, and supported if necessary by a "rest." Having opened his mouth as widely as he is able, he must breathe quietly, put his tongue rather forward against the lower teeth, and endeavour to depress and flatten, or render concave, its posterior part. After a little practice, the tongue can usually be brought into proper position. A few deep inspirations, alternated with repeated pronunciation of the broad vowel *a* (*ah*), often prove effectual. If all attempts are unsuccessful, the operator (seated exactly opposite) may use a broad tongue-spatula, which may afterwards be held by the patient himself. The introduction of any unnecessary instrument into the mouth should, however, be carefully avoided. Enlarged tonsils and tumours, or abscesses in the naso-pharyngeal cavity, give rise to difficulties not easily overcome.

When the soft palate, uvula, and posterior part of the pharynx are well exposed, the light (from whatever source) is to be directed full upon them. This having been accomplished, the laryngeal speculum, previously warmed by immersion in hot water or otherwise, may be introduced, with its reflecting surface downwards, into the mouth, carried backwards, and placed against the soft palate and uvula, or in contact with the posterior wall of the pharynx. Uncertain, hesitating, and hasty movements of the instrument are liable to give rise to objectionable titillations. The operation must be performed deliberately, confidently, steadily, and firmly. In such case it is from the first much less irksome and insupportable to the patient than might be expected, and, after a few repetitions, occasions comparatively little inconvenience. Sufferers from chronic laryngeal affections are the best patients,—not the worst, as some have supposed. Their desire for benefit is a stronger stimulus to patience and self-control than is possessed by the healthy, and moreover they are accustomed to submit their throats for examination, and the application of medicaments. The examination of cases of acute laryngeal disease is very difficult. It is, however, rarely necessary. The general symptoms are, as a rule, sufficiently characteristic. When the parts are too sensitive to be touched, the use of bromide of potassium as a local anæsthetic has been suggested,* but I cannot find on record any instance in which it has been tried. I have myself hitherto met with no case requiring resort to such an expedient, and have therefore no experience of its efficacy.

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* A frontal band made for me by Mr. Milliken, of St. Thomas's Street, leaves nothing to be desired.

The speculum, placed in position, will be well illuminated if the light is properly arranged, and consequently will exhibit to the observer an image of those parts upon which the rays are reflected from its surface. By varying the inclination of the mirror, and slightly changing its position from time to time, the following parts may be successively brought into view: the base of the tongue and glosso-epiglottidean ligaments, the epiglottis and arytæno-epiglottidean ligaments, the cartilages of Santorini and arytænoid cartilages, the true and false vocal cords, the ventricles and anterior wall of the larynx, more or less of the anterior wall of the trachea, and, if the glottis is very widely open and the light very good, even the bifurcation of the trachea. These several parts cannot be seen with equal facility; in many cases repeated attempts are necessary before success is attained. Numerous rules have been laid down as to the inclination and position of the mirror proper for the special examination of each particular part.† It is needless to repeat them. A few hours' patient practice on the dead subject, or, better still, on himself, will do far more to prepare the tyro in laryngoscopy for the successful examination of a patient, than the study of many pages of minute directions.

The practical Surgeon, who has acquired dexterity in its management, cannot fail to find the laryngoscope very serviceable. Experience has proved its value, and warrants its further application both in the diagnosis and treatment of very many affections of the larynx. In acute cases, which require prompt, decided, and active treatment, its use, as already intimated, is difficult or impossible, but is usually also unnecessary. In all chronic cases, however, repeated examinations should be made. Almost invariably patience and perseverance will triumph over the obstacles presented by the sensibility of the parts and the maladresse of the patient.

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* *Gazette des Hôpitaux*, 21st April 1860.

† Türck, op. cit.

Hoarseness, aphonia, and spasm of the glottis may each arise from a variety of different causes. The true cause can often be positively ascertained by laryngoscopy, and by laryngoscopy alone, during the life of the patient. In some cases, treatment before unthought of may be adopted, and prove successful, because appropriate.

By the aid of the laryngoscope, œdema glottidis may be assuredly diagnosed, and the knife accurately directed, if scarification of the parts should be deemed advisable.

Chronic inflammation of various kinds, with congestion, or thickening of the mucous membrane, and thickening of the vocal cords, can be easily recognised.

Certain of the milder forms of chronic inflammation of the larynx are distinguished from bronchitis with difficulty. The diagnosis is important, and may easily be accomplished by a visual examination.

Many hysterical affections of the larynx very closely simulate organic disease; and on the other hand the symptoms of organic disease are liable to be attributed to hysteria or some nervous affection. By aid of the laryngoscope it can be ascertained whether the vocal cords are perfect or destroyed; whether the muscles act or are paralysed; whether the motion of the cords is free and equal, or interfered with on one or both sides by any obstruction.

Ulcers, whether syphilitic, phthisical, or ordinary, can be readily detected; and caustic, if likely to do good, can be applied with certainty, and comparatively little pain, by means of a long and properly curved porte-caustique.

Tumours of the larynx are often accompanied by such symptoms only as are equally characteristic of other affections. The laryngoscope, however, not only reveals their presence, but affords facilities for their removal by an appropriate modification either of the wire-snare or *écraseur*.*

Foreign bodies in the larynx or pharynx may be seized and often extracted with comparative ease, when rendered visible by the laryngoscope.†

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* See a case recorded in the *Lancet*, November 1861, by Dr. Walker of Peterborough.

† Dr. Gibb of London (to whom, as well as to Dr. Walker, I am much

The limits of the present paper do not admit the introduction of details of any of the numerous cases which might be quoted from the experience of myself and others. Twenty cases are given at length in the work of Czermak already referred to, and which has been recently translated for the new Sydenham Society by Dr. Gibb. Many cases are to be found scattered through the foreign journals,—many more yet remain to be published.

In conclusion, it is frequently asserted that the laryngoscope is not adapted for general use, but must remain in the hands of the few. It may or may not be so. I can only repeat my conviction, that, even in the hands of the few, this simple but beautiful contrivance is destined to do much good to the many.

ARTHUR E. DURHAM.

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indebted for notes of many cases at present unpublished) informs me that he has thus succeeded in extracting a pin from the pharynx of a gentleman seventy-two years of age.

DISEASES OF THE ABSORBENT SYSTEM.

THE vessels and the glands of the Absorbent System are closely associated in their diseases, and cannot be conveniently or advantageously studied apart from one another. In the following essay, therefore, a separate notice of either part of the system will be taken only when some special facts of pathology or of treatment render it necessary.

Wounds of lymphatics. Although some of these vessels cannot fail to be injured in every considerable wound, they are rarely noticed. A little lymph doubtless issues from them, but it is mixed with the more copious and more important outflow of blood, or with the subsequent oozing of interstitial fluids from the divided tissues. The wounded lymphatic tubes may be sealed by the common coagulum of blood; it is probable, however, that the lymph also by its own consolidation contributes to this effect. "Dr. Monro inflicted a wound on the receptaculum chyli of a pig, which was cured in a very short time; and in the mean while the effusion of the lymph was prevented by its coagulation." The exceptions to this rule, and to the repair of wounded lymphatics by the ordinary processes of healing, are so few and rare, that the following instances of failure may be mentioned.

"A case of this sort I saw in a butcher, who, by letting his knife fall upon his shin, cut some of the large lymphatic vessels which pass over the tibia. From this wound there flowed a considerable quantity of a clear lymph, which, being confined by the dressings, jellied; and then, at first sight, appeared like a whitish fungus, but being loose could be removed with a spatula. My patient was cured by tight pressure, and lint dipped in a solution of vitriol."*

A. Monro, after removing a tumour from the arm, found the wound heal and contract "very fast, till a yellowish-white substance rose up from a small peduncle, at the part where the under part of the cephalic vein had been cut through. From this substance such a quantity of lymph oozed out from imperceptible orifices that the dressings were every day wet. I cut and eroded this substance away several times; but it quickly grew again, and the drilling of lymph became worse and worse, so that in a very little time it dropt so fast that I could have gathered a spoonful of it in a very short time. What cured it at last was, eating the fungus stuff and a little of the wound about with powder of Roman vitriol, and dressing the eschar with alcohol, which kept it from separating two weeks, in which time the orifices of the small pipes were soldered."*

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* Hewson, Sydenham Society's edition, by Gulliver, p. 198.

While this volume has been in the press, a valuable paper by Dr. H. Vandyke Carter, Professor of Anatomy and Physiology in the Bombay Medical College, has been presented to the Royal Medical and Chirurgical Society of London. Dr. Carter had met with three cases in which he had reason to think that chyle escaped by leakage or rupture from lacteal absorbent vessels. He expressed the opinion, with the grounds for holding it, that the disease known as "chylous urine" is not a functional error of any of the renal or digestive organs, but an accidental admixture of chyle with urine by the rupture of a lacteal vessel, concurring with a breach of the mucous surface in some part of the urinary tract. In one of the cases a similar fluid sometimes issued in a very large quantity from a spontaneously formed and very minute opening in the skin of the thigh.

Inflammation of lymphatics,—Adenitis, Angeioleucitis. In most instances of inflammation in the absorbent system, the vessels and the glands are both involved; the glands are rarely, the lymphatic vessels almost never, attacked alone. Many cases of inflammation of glands (*adenitis*) are regarded as spontaneous, or as the result of the direct influence of cold, until a careful inquiry shows them to be dependent on a prior irritation of the afferent lymphatic vessels (*angeioleucitis*). It is by no means unlikely, therefore, that some inflammations, which are now considered to be instances of primary adenitis, may yet be found to be secondary to some hitherto undiscovered primary cause of the same kind.

Inflammation of the lymphatics occurs in many parts of the body. Traces of it are sometimes discovered in the interior of the trunk, after death, by the various changes it has produced; by serum or pus; by thickening, opacity, or accumulated concretions in or about the lymphatic vessels. But it is hardly ever actually seen except in connexion with the skin or an ulcerated surface.

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* *Medical Essays*, Edinburgh, vol. v. art. 27.

The disease, as it thus comes under the observation of Surgeons, is usually an acute inflammation, originating in some previously irritated or inflamed tissue, extending in long narrow lines in the course of the absorbent vessels, and involving the nearest gland. It is often attended with heat and a transient redness of the adjoining skin, with considerable pain, and with rather severe symptomatic fever; and it may issue in an effusion of serum and lymph, in suppuration, and in blood-poisoning.

Most inflammations of the absorbents start from an open wound. Such a wound may be in almost any condition, and of any form. It may be punctured, cut, torn, blistered, torpid, healing, scabbed. The mere state of the wound does not determine the occurrence of the inflammation. It may, indeed, manifest itself after the absorption of a poison without a wound, as when red lines cover the penis from recently contracted gonorrhœa; even breathing the exhalations of corrupting animal matter may occasion it, although the wound from which the angeioleucitis afterwards spreads be at the time sedulously covered; but there is in most cases ample evidence of direct infection of the wound. The morbid matter may be some local inflammatory product, as when the inflammation follows the prolonged friction of excoriated skin, or the confinement of the secretions of a sore by a hard scab. More commonly, however, some irritating or poisonous material is known to have been applied to the wound from without; or some gaseous poison, though not known, may be the real, as it is sometimes the ascertained cause of the inflammation. My colleague, Dr. Greenhow, describes inflammation of the absorbents of the arm as succeeding a diphtheritic exudation beneath a vesicle of the hand.* He has seen the same occurrence in the neck, connected with diphtheria of the throat, and fatal. Once only, and in a very rapid case, I have known an acute inflammation of the lymphatics, with redness of the skin, to accompany and indicate the first infection of the glands with secondary cancer. See p. 277.

The course of the inflammation is commonly pointed out by a linear redness of the skin, which is often many times broader than the vessel beneath. The lines follow the direction of the absorbents, not of the veins; and in the arm they may cease at the wrist, or the elbow, or at any intermediate part at which the inflamed lymphatic vessels end in a gland, or lose relation with the skin; but they never pass the armpit. The tenderness along such inflamed tracks is excessive, and it commonly extends to the next absorbent gland, whether the redness reach so far or not. The rapidity with which such lines are sometimes formed is remarkable, and is only equalled by the instantaneous ophthalmia which occurs when a foreign body enters the eye. "Mr. Hunter saw a case, in which the skin being pricked by a needle which had never been used before or touched any infectious or irritating substance, occasioned the lymphatics of the arm to inflame, and show themselves in the form of red lines, running towards the axilla; in consequence of this, some one of the glands there also inflamed and swelled, the patient had rigors and sickness, and all this in the space of a few minutes."*

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* *On Diphtheria*, p. 196.

Such extreme rapidity in the development of inflammation is unquestionably rare, although Cruikshank states that he has seen other similar cases in the instance of the absorbents. The red lines, indeed, are not invariably formed; and this may be readily understood, if they be regarded as occurring only when the inflammation is widely spread, and therefore rather intense. It is not improbable that the skin is thus involved through the medium of the minute cutaneous lymphatics connected with the inflamed vessel; and the likeness of the local appearances to the blush of erysipelas, together with the transitoriness of the appearances in the skin, whilst the tenderness of the inflamed vessel continues, rather confirms this view.

The inflammatory action, as indicated chiefly by these red lines, sometimes extends slowly, and as it were continuously, by the tissue of the lymphatic vessels; far more commonly it attacks them simultaneously in nearly their entire length, and appears to be consequent on their becoming filled with fluid of an irritating quality. That the latter is the mode of origin is further likely from the fact, that the disease travels only upward from the wound to the next gland, and not in the opposite direction. It will extend, for instance, from a wound on a knuckle to the axilla, but not along the finger; from the heel to the ham, but not to the foot. There are some apparent exceptions to this rule, but they are probably to be explained by the continued absorption of noxious matter at the wound, and its accumulation below some point of obstruction in the track of the lymphatic vessels. A woman came under my care with a series of eight abscesses between her finger and armpit.

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* Cruikshank *on the Absorbents*, p. 76.

The highest was on the inner and posterior part of the upper arm; the lowest was on the back of the hand. They differed in size by a regular gradation from the highest, which equalled a walnut, to the lowest, which was no bigger than a cherry, and was the least mature as well as the smallest of all. There was no suppuration in the axilla. They were all punctured, and got well; yet inflammation and œdema, if not suppuration, eventually took place at the finger. It was clear that the highest abscess, being the largest, was the first formed; and that each of the others successively arose next after the one above it. The only cause which appears assignable for the later abscesses is, that fresh matter arriving from the finger accumulated below the preceding ones, until at last, by the inflammatory action in the finger, the source of the irritation was got rid of. Wiseman describes a similar inflammation, which apparently descended along the absorbents of the thigh and leg.* A man came under my care for suppuration spreading from the axilla and reaching down the side of the trunk to the loin. Vast quantities of matter were evacuated by dependent openings, and the suppuration was restrained by appropriate bandaging, injections, medicines, and food. As the discharge subsided, the hand began to suppurate in a spot from which inflammation, spreading by the absorbents, appeared to have first originated the abscess in the axilla. The man recovered.

The inflammation ceases at the nearest gland. This is a fact abundantly exemplified both in the simple and the specific inflammation of absorbents. The known situations of the superficial glands are those towards which inflamed absorbents may be traced, and at which their inflammation culminates to its highest degree of severity, and is almost invariably extinguished. The gland appears to arrest the free progress of the acrid lymph, by itself becoming inflamed. Sometimes the current of morbid lymph through it is completely stopped; at other times it gives passage to the lymph, or itself supplies morbid material to the higher absorbents and the circulating blood. Even in that case, however, the higher glands do not inflame or suppurate. Did they do so, we should commonly see abdominal abscesses, peritonitis, &c., in primary syphilis, and inflammation in the neck combined with traumatic suppuration in the armpit. The inflammation of a gland, which is excited under these circumstances, may vary from a slight increase in its size and firmness, with some tenderness, to a degree of severity, which issues in extensive suppuration. The gland in the former case may be felt rolling in the tissues, almost as readily as in health, and its tender and swollen state outlasts the inflammation of the afferent lymphatic vessels by a few days. It may, however, enlarge to twice or thrice its natural size, and continue swollen and tender for two or more weeks. This is especially noticeable in the case of a gland near the femoral ring; the tenderness, tension, even surface, and position of which sometimes cause it, when recently inflamed, to be mistaken for a strangulated hernia, especially if at first there should concur with its inflammation some nausea and constipation. Or, further, the gland may suppurate. This event may not ensue until a week or more after the inflammation of the lymphatic vessels has passed away. It is sometimes indicated by a renewal or increase of the local pain, and by rigors and other constitutional symptoms. But not at all unfrequently suppuration occurs in a gland without any local symptoms which attract notice. The first pain attending the inflammation having subsided, a patient may be unconscious of any disease in his armpit, while matter to the extent of half a pint or more may be collecting there and behind the pectoral muscle. Suppuration is rarely limited to the area of the gland. The suppurating structure is rather the loose areolar and adipose tissue in which the gland is imbedded, and which here, as elsewhere, is observed to suppurate with a less degree of inflammation than that which already exists, without exciting suppuration, in the inflamed organ. Abscesses connected with inflamed glands may therefore reach any size which their position allows; they are, for instance, prone to be larger in the loose tissue and spacious area of the axilla than in any other region occupied by superficial glands. The matter discharged from them is thick and well formed; and after it and any slough which may have been produced by the intensity of the inflammation have been evacuated, the cavity closes. An abscess in the armpit or groin soon heals, but in the popliteal space the cure is not unfrequently slow.

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* *Chir. Treat.* 1692, p. 48.

Inflammation and suppuration of the glands appear to be eliminative as regards the afferent lymphatics and the injured distal parts, and protective as regards the circulating blood. During the continuance of suppuration in the axilla, the activity of inflammation in the distal parts subsides, as gonorrhœa is often temporarily suspended so long as a bubo is forming or freely discharging.*

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* " Ubi pestis minus sævo morsu lacessit, in molliores decumbit glan-

On the other hand, the poison which has reached the gland by way of the lymphatics does not pass beyond it. When, however, a cutaneous pustular eruption comes out on the trunk, or severe constitutional symptoms, like those of pyæmia, arise, it is clear that the morbid poison is not limited by the gland in the manner supposed. Of the various hypotheses by which these occurrences may be explained, those seem most consistent with the anatomy and the other diseases of the absorbent system, which assign the pustular eruption to the anastomosis of minute cutaneous lymphatics, and the infection of the blood to the glandular suppuration itself. In the former case, the poisonous matter which is held back by the suppuration traverses the collateral channels, and produces pustules wherever it filters over the vast area of skin subordinate to the obstructed glands. In the second case, the matter from the gland itself is assumed to find a ready passage along the efferent lymph-tubes into the blood.

The constitutional symptoms attending an attack of acute angeioleucitis are sometimes severe. Rigors, nausea and vomiting, heat of skin, thirst, dryness and coating of the tongue, with constipation, sleeplessness, and considerable nervous agitation, a quick bounding pulse, and a feeling of langour, are usually the severest accompaniments of the disease. If the fever be typhoid, if there be profuse fœtid sweats, severe muscular pains, high excitement, a dry burning heat of skin, and marked delirium, the poison is no longer limited within the lymphatic channels, but has infiltered the cellular tissues, and has tainted the blood.* As the inflammation subsides, and local suppuration, a cutaneous eruption, or fœtid discharges from the bowels, come on, the general symptoms become those of exhaustion.

The cases depicted in the foregoing description are those of considerable but of ordinary severity. There is much variety in this respect, however, in different cases. There may be a mere passing soreness, with some enlargement and hardening of a gland, whilst the intermediate lymphatics between the wound and the gland have either not inflamed or been so little irritated that no pain or inconvenience had been felt in them. A hard cord

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dulas, quæ ad corporis superficiem prominent; quales sunt inguinales, axillares, &c. Si convalescere datur ægrotanti, tumores ii, uti in variolis, legitimam nanciscuntur suppurationem, morboque naturam hac via exonerant." Mead *de Curatione Pestis.*

* See Erysipelas, Animal Poisons.

may be felt beneath the skin, leading to a tender swollen gland, but there may have been no red lines, and there may be no suppuration. There is sometimes an axillary abscess without the previous occurrence of red lines, and the latter may form without occasioning any axillary tenderness. Sometimes the track of the absorbents is tender for a day or more before the red lines appear, but more commonly they are amongst the earlier symptoms of the inflammation. In one case I have seen red lines appear twice between the wound and the armpit. No suppuration took place in the inflamed gland, but a pustular eruption over the trunk seemed to show that some poison which had passed the gland was being eliminated by the skin. In another case the absorbents inflamed without occasioning the linear redness on the skin, and three abscesses formed in the axilla. There was in this case no cutaneous eruption. When suppuration occurs, it most commonly does so only in the gland; but it may take place in the absorbent track, without involving the gland, or may affect both the vessels and the glands. In the later progress of the severer cases additional symptoms and pathological changes may result from particular constitutional tendencies of the patient. Thus I have known inflammation of the absorbents of the arm terminate in fatal acute œdema of the tongue, the absorbents being infiltrated from the thumb to the submaxillary gland.

Simple traumatic inflammations of the absorbents prevail in particular localities. They are very much more common in the arm and axilla than in any other parts of the body. A similar observation has been made respecting plague, and the reason in both cases appears evident. The hand, from which these inflammations originate, is at once more liable to injury, and, except the face, more exposed than the rest of the surface. Glandular suppurations in the mesenteric, lumbar, and bronchial glands are as small as they are rare, and only some of the cases of iliac and pelvic abscesses following upon parturition are to be compared in extent with those in the armpit. In one situation glandular suppuration calls for an especial notice, viz. at the lower part of the left side of the neck. A severe and deeply seated acute suppuration is apt to form in that situation, and, as it is bound down by the fasciæ and platysma of the region, it may continue long without finding an outlet. It occasions great swelling, œdema, tension, and pain. The root of the neck is much raised by the swelling, and the clavicle hidden. In all the cases which I have seen, the abscess was on the left side of the neck, involving the whole region of the cervical part of the thoracic duct, and not extending into the axilla. The cause of these great and severe suppurations is sometimes obscure, and they may not always originate in disease of the lymphatics; but sometimes such a mode of origin does appear, and in one of my cases an enlarged tender gland was described as having been first felt. It should also be remembered from how many parts lymphatics converge towards the left side of the neck. This is the only situation in which I have known an acute and severe suppuration subside without the external discharge of the pus.

Inflammation of the lymphatic glands, *adenitis*, sometimes occurs alone, *i. e.* without any previous perceptible inflammation of the afferent vessels. It does so after some of the fevers of childhood. The higher cervical glands are then very liable to swell and become painful. Being in the neighbourhood of the lower jaw, tongue, and pharynx, all movements of these parts are restrained, and a good deal of suffering attends mastication and swallowing. Such cases of adenitis follow scarlatina, and are sufficiently explained by the state of the throat. The cause, in other cases, is probably to be found in the combined influences of external cold and the circulation in the glands of blood and lymph charged with the noxious elements of the fever. These cases are not to be confounded with those of true cynanche parotidea. An absorbent gland in the centre of the parotid may inflame as lymphatics inflame elsewhere, but its disease does not produce the characteristic, contagious, and metastatic affection commonly known by the name of mumps.

Treatment of inflamed absorbents. Many of the ordinary duties of life expose persons to this painful affection; and it often arises in circumstances to which busy manual labourers pay no attention. A layer of collodion upon a small wound or puncture, or of court-plaster upon a longer wound, might avert many of the attacks of inflamed absorbents; but, as a matter of fact, little or nothing is done in such cases in the way of prevention.* When patients with wounds of any kind are under medical advice, the common precautions of cleansing the wound, securing the proper action of the purifying organs, and avoiding unhealthy diet, air, and occupations, are enough to prevent such attacks. Upon the occurrence or threatening of an inflammation of the absorbent vessels, those measures will be found to succeed best which remove the cause, repress the violent local symptoms, and moderate the constitutional reaction. The wound should in all cases be thoroughly cleansed. It should be opened, put under a stream of water, syringed, or soaked in a thoroughly hot bath, as may best suit its form and condition. If recent, or punctured, it should be sucked, and then touched throughout with a stick or pencil of nitrate of silver. If flabby, it should be stimulated with a suitable mineral lotion. If fœtid, it should be wrapped in solutions of Condy's or Burnett's fluid, or in chlorinated lotions. If sloughy, it should be covered with Peruvian balsam and a poultice of linseed meal, charcoal, or beer-grounds. Heat is in all these cases grateful to the patient, and if often changed, in order to secure the cleansing of the wound, a poultice will generally be found the best local application.

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* The practice of smearing the hands with oil before touching noxious fluids is found to prevent the mischiefs which might arise from absorption, and is of great value at post-mortem examinations.

The lymphatics themselves are best treated by the nitrate of silver. It should be wiped a few times on the moistened skin along the red or tender lines. Care should be taken not to apply it too freely, as the subcutaneous inflammation can be as effectually moderated by blackening the skin as by blistering it. After soaking and applying caustic, the Surgeon may wrap the limb in cotton wool, and enjoin complete rest.

The glands in the early stage may not have shared the inflammation, yet the nitrate of silver may be applied over them also, and the use of it should in all cases be carried higher than the tenderness and redness of the surface. The removal of all further irritation from the wound, and moderating the inflammation of the lymphatic vessels, will in most, but not all, cases secure the patient from suppuration in and near the glands. If further means appear requisite for this end, they may be found in leeching, and the application of ice or a cooling lotion to the surface. I have not, however, found cold adapted to arrest threatened suppuration in glands. Heat is commonly more grateful to the patient than cold in such cases. It may be employed in a bath or in the form of steam. The latter may be directed from the spout of a kettle against the tense and painful part by means of a paper tube. If the inflammation continue, mercurial ointment is also useful; it should be laid not only over the gland, but along the track of the previous lymphatic inflammation, which has already indicated the natural channel for absorbed remedies to reach the inflamed gland. It may be observed, however, that in not a few instances, when once the glands have inflamed, no treatment averts suppuration, and special attention must always be directed to them for a week or two after the first inflammation, in consequence of the occasionally insidious progress of abscess after adenitis. When acute glandular abscess is advancing to the surface, and occasioning much pain, it should be opened. But if there be any reason against this treatment, much relief to the suffering, and some acceleration of the pointing, are obtained by leeches. From one to three leeches are quite enough for this purpose; a larger number would have the effect of retarding and diffusing the suppuration. In like manner the slow progress of a chronic abscess of glands may sometimes be quickened by the application of a small blister upon the prominent part of the swelling.

The treatment in the lymphatic inflammations of convalescents is chiefly that which will relieve the pain and guard against the somewhat rare event of suppuration. Steam, followed by an application of cotton wool, ordinarily serves this purpose, and pure air, without draught, is also of much importance.

Hypertrophy and atrophy of glands. One of the first facts observed in studying the lymphatic system is, that in disease, and still more in health, its condition varies with that of the tissues from which its vessels spring. So far as age defines the activity of growth and nutrition, the glands vary with it. They are proportionally larger in children than in adults, and in these than in persons advanced in life. But with premature emaciation of other tissues glands also waste before their time, and they have been found larger in a well-nourished woman at ninety years of age than in one who at fifty had died exhausted by chronic disease.* In wiry, slender people the glands are small and firm; they are succulent and large in persons characterised by softness of fibre, a thin fair skin, and some embonpoint. Even in the same body the lymphatics differ from one another according to the tissues with which they are associated, the structure or functional activity of the primary organ entailing some corresponding variation in the texture, the size, and even the number of the subordinate lymphatics. There is, for instance, less glandular structure in the course of the absorbents of one of the lower extremities than of one of the lungs, great as is the difference in the bulk of those parts. The largest of all the absorbent vessels are those found in connexion with the uterus at the period of parturition. And as in size and number, so are there differences in the texture of various lymphatics. "The glands of the thigh or arm will sustain a large column of mercury without bursting; whilst the glands on the mesentery, or on the lumbar vertebræ, easily burst." For "these last resemble the viscera of the abdomen and thorax, whose texture is much more delicate and tender than that of the external muscles."*

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* Gulliver's *Hewson*, Sydenham Society's edition.

The transition is imperceptible from an hypertrophy or enlargement of glands, which corresponds with the state of the tissues, to one which is strictly morbid; and in practice it is scarcely to be defined. A general fulness of all the glands concurs in some persons with rickets, a large brain, and a hypertrophied thyroid gland. In other cases, the large succulent glands, which are met with in children of soft loose fibre, seem readily to receive the yellow deposit of actual disease. There is also a class of chronic enlargements of the glands, which are occasioned by no traceable inflammation of the afferent lymphatics, and are attended by no pain, and but rare liability to suppuration. They have been described by Dr. Hodgkin in the *Medico-Chirurgical Transactions*, vol. xvii. The specimens preserved in the Guy's Hospital museum are of very large size, a single gland being three inches or more in length. They are smooth, uninflamed, and entirely free from scrofulous deposit. They are said to have been of semicartilaginous hardness, pale, uniform, non-vascular, and slightly translucent on section. They were observed almost universally throughout the body, and accompanied with an enlargement of similar appearance in the spleen. They occurred both in children and in middle life; sometimes, but rarely, they suppurated; and they proved fatal by the anæmia and exhaustion which attended them. Such glands, as well as those which are plainly strumous, may by mere bulk occasion great inconvenience when lying near ducts, vessels, and nerves. Death has been attributed to their encroachment on the bronchi. Their presence in the pelvis is said to be capable of interfering with parturition, and when pressing on the trachea they have occasioned so much distress that the subcutáneous division of the sterno-mastoid has been thought advisable to relieve the breathing.†

When these cases are excepted, and those which are referred to in other parts of this essay, there are few slow enlargements of the glands left which can be assigned to mere chronic inflammation. Some such cases, however, inasmuch as they yield to a mild mercurial course, are assumed to be of that nature. The case had need be very clear which could admit of such treatment; but the fact of its occurrence justifies the treatment in cases which are unmarked by constitutional disease, or which do not yield to the milder measures recommended for the treatment of scrofula. The mercury should be prescribed in small doses, and be combined with some tonic. Quinine and calomel, the bichloride of mercury in decoction of bark, the biniodide of mercury in the form of a pill, and calumba, cascarilla, quassia, or sarsaparilla,—any such combinations may be adopted. Dr. Hodgkin was disposed to rely on the use of liquor potassæ in the management of the cases which he described, but he had no opportunity of testing the remedy. The state of the glands in cases of rickets rarely rises into importance as compared with the other disease. When it does so, it is chiefly on account of suppuration taking place in them, with every indication of a strumous character. Local treatment may go on at the same time; ointments or washes made of mercury, iodine, opium, or of combinations of these remedies, being continuously applied. Blisters are to be avoided in glandular inflammations. They necessarily irritate the lymphatic vessels of the skin, and tend to aggravate, rather than moderate an existing inflammation. A leathern plaster left constantly on the surface is more effective in reducing the swelling, and it may be medicated in any manner suitable to the case; the various emplastra of the Pharmacopœia affording choice enough for that purpose.

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* Cruikshank *on the Absorbents*, p. 71.

† Gross, *Surgery*.

Strumous disease in the lymphatics having been selected to illustrate the subject of Scrofula, it will not be necessary to repeat in this place so much of the description of the glandular disease as was required for the general article on that subject. It may be almost wholly studied in vol. i. pp. 350 et seq. Some further facts must, however, be here stated in order to complete the surgical account of the disease.

Strumous disease may occur in glands with the inflammation which often succeeds the eruptive fevers of childhood and youth. Measles, varicella, scarlatina, &c., are not uncommonly followed by an enlargement of the cervical glands, which may become chronic, and assume the characters and course of struma. Scrofula may also originate in glands, upon some irritation or disease of the tissue or organ with which they are connected. It appears to be produced in the ordinary way of inflammation of lymphatics, but to be modified by the state of the constitution in which it occurs. Sometimes an injury, far more frequently a slight chronic ailment in the skin, occasions an enlargement of a gland or glands, the deposition of strumous matter in it, and subsequent characteristic softening, which can hardly be described as suppuration. Many enlargements of the cervical glands may thus be traced to eruptions on the scalp; some to inflammation or suppuration of the ear; others to the irritation of decayed teeth. Again, there are affections of the glands with struma, traceable to primary disease of the same nature in the organ to which the glands are subordinate. Scrofula is thus repeated, after the manner of cancer, in the spermatic and lumbar glands from tubercle in the testis; and, like cancer, too, it will increase in the absorbents, and prove fatal after the extirpation of the organ which was primarily diseased. Bronchial glands are often tuberculous in correspondence with the lungs; a gland over the masseter with the blear eye, or strumous lippitudo, &c.

But there are not wanting cases in which a primary occasion for the disease in the glands cannot be discovered, and in which the cause may be some undefined fault in the nutrition of the tissues. For whilst, in some instances, only the bronchial glands are tuberculous, there are others in which they only are exempt from the disease. Some patients have only an enlargement of the lacteal glands, the lymphatics being every where natural; in others the disease is entirely limited to the general absorbents, those of the bowels being healthy. Some patients, again, have a universal disease of the glands. In these instances, the extensive disease can only be supposed to arise from some general cause, as distinguished from a local irritation.

The diagnosis of strumous disease of glands is rarely difficult. The large, clustered, movable, tuberous masses which they commonly make in the neck, axilla, or groin, can be always recognised to be glandular, and there is but one other disease which is liable to be confounded with them. Medullary cancer sometimes grows in many glands and to a large size, and forms a cluster in the manner of those of scrofulous nature. But glandular medullary cancer without a distinctive recognisable primary growth is extremely rare, and in the presence of such a growth the difficulty of diagnosis could not occur. In the few instances in which cancer does happen in glands alone, it may at first be but uncertainly distinguished from strumous disease, by its more rapid growth, its less isolable and softer lobes, its elasticity, and sometimes by its electric pain. The late progress of the cancer to vast size, livid elastic protuberances, and fungous bleeding openings, are plainly distinct from the slow enlargement, the shallow suppurations, and the flaky puriform discharges of the scrofulous tumour. But little assistance can be derived from the age of the patient, as the majority, both of strumous and medullary diseases of glands, occur before puberty. A single strumous gland is very liable to be mistaken for a tumour of other nature, especially when it has suppurated, and has remained long encysted. The distinction can only be drawn by the history of the case, the appearance of the patient, and dexterous manipulation on the part of the Surgeon.

The *suppuration* of strumous glands, though commonly slow and immature, is occasionally acute, copious, and attended with rapid emaciation and weakening of the patient. This seems to be particularly the case with strumous glandular abscesses in the groin, which sometimes equal the largest orange, and discharge as much as three-quarters of a pint of muddy, ill-formed pus, mixed with large quantities of yellow scrofulous flakes. Even when opened comparatively early, or while yet forming, these acute strumous abscesses are attended with hectic, and a general debility not less severe than that which accompanies the softening of tubercle in the lung.

Far more commonly the chronic abscesses connected with scrofulous glands are remarkable for their slow progress, the occasional variations in their condition, their rather frequent spontaneous removal, their feeble efforts at repair, their burrowing, and sometimes for the copious and even fatal hæmorrhage which they occasion. They appear to be most commonly formed outside the gland, and to have therefore one part of their surface, viz. the gland, in a state of disease. The matter which is formed in them is not pure pus, such as leads to a vigorous inflammatory process in the tissues around it, but yellow tuberculous lymph, and a serum so thin and slightly cloudy as to suggest that it may be but lymph which has escaped from unhealed lymph-tubes and cavities in the gland. Sometimes the abscess becomes flaccid, from a part of its contents being absorbed, or removed by the way of the lymphatic vessels; and sometimes the fluid part entirely disappears, leaving only the solid yellow material behind to shrink, and after a long period to become cretaceous. A strumous abscess rarely points; it generally widely undermines and destroys the healthy skin which covers it; it burrows also among the areolar tissues, which, as has been said, do not resent its encroachment, and enclose it by a compact dam of lymph. The opening of such an abscess, therefore, is but the opening of one portion of a sinuous and perhaps branching canal. In its deeper parts it may extend to the vicinity of large blood-vessels, and disastrous results may ensue. The internal jugular vein is sometimes obliterated and contracted near such an abscess; two or three inches of it may be entirely removed, and its upper and lower orifices plugged with lymph. Arteries in such circumstances, on the contrary, may ulcerate; and not a few cases are on record in which large quantities of arterial blood have poured from strumous ulcers involving the internal carotid. Mr. Syme* describes such a case, in which the hæmorrhage issued repeatedly, and even after the ligature of the trunk-vessel, from an abscess beneath the ear, but was finally stopped. My colleague, Mr. De Morgan, tied the common carotid for profuse arterial hæmorrhage from the tonsil in a case of strumous disease of the higher cervical glands. The patient rapidly and entirely recovered from phthisical as well as the local strumous symptoms under which he had been labouring.

The *treatment of scrofulous glands* is in great part constitutional. The disease being of slow growth, and based upon gradual impairment of the general nutrition, a rapid improvement is not to be expected, and the measures adopted must be continuously persevered in for a long period. When it is remembered, too, that in some instances external glandular has been observed to alternate with the far more perilous tubercular disease of the lungs, and that in very many cases the supervention of the latter disease upon the former is fatal, it will be seen that any treatment is to be eschewed which abruptly represses the disease in the glands. Good air, nutritious food, ample and cheerful exercise, act imperceptibly but continuously upon the system, and supply the best means of reducing, as the contrary circumstances do of originating, scrofula. If, therefore, the complete removal of the disease and its cause is to be accomplished, these advantages must not be supplied for a short time only: the citizen must take up his residence in the country, and the various hygienic conditions of good health must be permanently adopted. In the selection of a locality, it is an error to suppose that the mild moist climates of the southern and western coasts of our island are equally suited to all patients. Most of the earlier cases do better in the bracing air of the higher lands, where they attain a better standard of health and more bodily vigour than in the relaxing regions near the sea. Struma of all forms, in its later stages, is unquestionably benefited by sea air; but at suitable seasons it is far from invariably injured on the high lands.

The medicinal management of strumous glands is amply described in the essay on SCROFULA, vol. i. pp. 355 *et seq.*

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* *Contributions*, &c., 1848, p. 264.

The acute suppurations of struma need early evacuation by the Surgeon's knife, as much as other abscesses; and in order to avoid the drain upon the patient's strength which they cause, they should be carefully syringed out, injected with lotions of gallic acid, powdered opium, bark, iodine, or with the more stimulating metallic solutions of silver, copper, or zinc, and then accurately bandaged and compressed. Their discharges, in fact, must be lessened as much as is consistent with the necessary expulsion of their unorganisable contents and walls. The patient will require ample food and stimulants from the first.

In respect to the treatment of chronic strumous abscesses, little need be added to the general remarks made in the essay on SCROFULA. It should never be forgotten that some such collections of ill-formed pus are reabsorbed. There are a few cases in which, although the matter is advancing to the surface, but without actually pointing, the abscess may be punctured obliquely by means of a trocar of suitable size, and freely and repeatedly syringed out. The puncture may then be closed and the cavity compressed, with the hope of its walls cohering. When the abscess has undermined a wide tract of integument, the attenuated skin is often irrecoverably destroyed. It becomes livid, opens, and is very slowly ulcerated. Its presence interferes with the free discharge of the matter, and prevents the cicatrisation of the abscess. Very much time is saved by the application of caustic to the whole integument so thinned, as upon the separation of the slough the whole base of the abscess is exposed, and its margin is in a state to cicatrise. Long irregular sinuses, which undermine the skin in the same manner, may be laid open by the knife in their whole extent, or at suitable intervals by limited applications of caustic. The majority of such cases will then heal under pressure. In a few persons, however, no surgical treatment whatever secures the closure of these burrowing fistulous ulcers. They may be slit open, cauterised, injected, pared along their edges and to their very extremities; yet they will burrow still. Nothing but a change of residence and great improvement of the general health proves successful. Massive and projecting strumous glands, to which the integuments fail to adhere, and the presence of which retards or prevents the healing of the abscess, may be destroyed by piercing them with sharp sticks of caustic. Upon the expulsion of the slough, such sores become level, and may heal.

Lymphatics in syphilis. The actions of the lymphatics when infected with syphilis supply so important a part of the general doctrines of that disease, and have been so amply described in Mr. Lee's essay, that reference may be made to it for all information (vol. i. p. 375).

There is a form of molecular absorption which I have never seen ascribed to syphilis, but which has appeared to me to be one of the later effects of that disease. In persons who have had venereal affections many years before, and in some who still present some tertiary forms of that disease, the tips of the fingers or toes become remarkably stunted. At first a pit is found in the pulp at the end or on the palmar surface of the digit, having no pus or scab, nor yet healthy skin at the bottom. Towards this pit the rest of the pulp and the nail are slowly drawn, and as they approach it are absorbed. Every structure of the finger, including the bone, is progressively removed, until at length, in place of a phalanx of three-fourths of an inch in length, all that remains beyond the last articulation is a rounded stump of the bone, not a quarter of an inch in length, and covered with tightly stretched, thin, dry skin, without a vestige of the nail. The whole process may occupy many months or years in progress, and for the whole time is unattended by visible ulceration. The fingers are stiff, and often comparatively useless, from the tenderness of their extremities, so long as the disease is going on. In some, but not in all cases, the skin of the hand or foot is affected with lepra anæsthetica, or with psoriasis, or is dry and scurfy. I have, however, observed it to be quite healthy.

Lymphatics in gonorrhœa. The lymphatics in this disease sometimes share in the intensity of the local inflammation. The penis may be covered with red lines, and the inguinal glands inflame and suppurate on one or on both sides. This whole subject will be found treated in the essay on GONORRHŒA.

Lymphatics in cancer. For facts connected with cancer in the glands, reference may be made to the essay on that subject in vol. i. p. 508. Some additional remarks bearing on diagnosis will be found in the section upon the state of the *glands in innocent diseases.*

An absorbent gland infected with cancer may contain the minutest speck of the disease. I have found under the microscope in epithelioma a single small spot of characteristic cells in a whole field of perfectly healthy glandular structures. But it often entirely ceases to be a gland at all. The whole structure is replaced by cancer. In certain situations the disease extends to all adjoining tissues, and involves and destroys all the glands of the region. Secondary cancers in the groin, for example, following primary disease of the penis or vulva, may thus exterminate all the inguinal lymphatic system, and, when they ulcerate, may give an outlet for a copious discharge of lymph. In such a case I have observed not only considerable œdema of the foot and genital organs, which was due to the hindered circulation of the lymph, but a wasting also, and in one instance an almost complete conversion into fat of glands in the lumbar region, as if their function had been lessened or abolished by the isolation of the lower limb.

Far more commonly the rule is observed that cancer reproduced in the lymphatics becomes diffused throughout the system.

Cancer of the lymphatic glands is rarely difficult to recognise. In the large majority of cases some primary tumour claims the chief attention, and determines the nature of the secondary affection. When the glandular disease so far exceeds that of the primary tissue as to be first observed, it may be distinguished to be scirrhous, sometimes by the contracted shot-like tumours to which the glands are first reduced, sometimes by their being enlarged, sometimes by their being clustered together into an irregular tumour. The characteristic hardness of scirrhus is more commonly noticed in the first case, since, when scirrhus occupies but a part of a gland, the remainder of it may swell and cause the whole to feel comparatively soft; and when it occupies one or more entire glands and grows beyond them, the whole tumour is stony only so long as degenerative softening in it is delayed.

The distinctions of encephaloid cancer of glands are stated at p. 272, and those of the epithelial form of the disease in vol. i. p. 530.

The first occurrence of cancer in a gland may take place quickly or late after the formation of the primary tumour. In some instances the secondary disease is even observed first; in others, the lymphatics escape infection altogether. Upon what these various facts depend is not known, but it is interesting to observe that they have their parallel in the pathological actions of the lymphatics after the insertion of a poison into the body. Sometimes they inflame with great rapidity, and sometimes they are not affected at all. Sometimes their inflammation is delayed, and in the case of the inoculation of smallpox it is not until the seventh day that the glands inflame. The advance of cancer to the glands, and its commencement in them, are almost invariably unnoticed. In a case of mine, however, one of primary and still unulcerated cancer of the hand, the absorbents were first affected with inflammation, red lines suddenly arising on the skin, and a gland enlarging, which soon assumed the character of cancer. The patient was a well grown womanly girl of fourteen, and the disease of medullary nature, and extremely rapid in its progress.

When once established in a gland, cancer usually pursues its course like any other secondary tumour. It may attain a very moderate or a vast size; it may be stationary, or may wither; it may appear dependent or independent on the primary growth or on the growth of other tumours in the body. These facts are sufficiently stated in the article on Cancer. It may be added, that no cases of an universal tainting of the lymphatic system with cancer are ever observed, as is sometimes the case with tubercle. Cancer appears to travel along the absorbents in a manner which is explicable by the anatomical arrangements of those vessels, and not to affect the system as a whole.

The glands in innocent diseases. Lymphatics appear to have no special relation to the functions of the several parts with which they are connected. Organs having only blood-vessels, and those provided also with an excretory duct, equally possess a system of absorbents. The glands may therefore be said to be appended to the tissues, as such, and may be expected to vary with those tissues in their condition. That they do thus vary within the limits of health has been already stated in the section on *hypertrophy of glands;* and the probability is that they are consecutively altered by every morbid variation in the condition of the tissues.

In practice, however, such morbid variations are not appreciable, unless they cause a change in the size, form, or density of the glands. So far as Surgery is concerned, glands not appreciably affected pass for being healthy.

The importance of the question as to the state of the glands in various diseases is shown by the general fact already alleged as to their implication in cancer, in contrast with their condition in relation with those tumours which, practically and in respect to the object of inquiry, may be classed as not malignant. Although at th commencement of cancerous growths the glands are rarely affected, yet they are sometimes both early and most extensively diseased, and at some period before death they are almost uniformly invaded. Even the bony substance of osteoid is reproduced in the glands. An affection of the lymphatics by any innocent tumour, on the contrary, in the same sense in which they are involved in cancer, is very rare, probably as rare as the case of glands unaffected in that disease. They may indeed be enlarged in connexion with an innocent tumour, but it is because irritation of the skin or ulceration likewise exists. Such enlargement is a transient inflammatory swelling, not a reproduction of the primary disease in the gland, and is no more to be ascribed to the presence of the tumour than if none existed.

Reserving such cases, I may enumerate the following diseases in which no appreciable affection of the lymphatics is observed: all simple hypertrophies of any organ or part, and all tumours which present some likeness to the structure in which they are formed. Fibrous tumours of the uterus and prostate, therefore, mucous polypi, chronic mammary tumours, cutaneous thickenings and mollusca, adipose tumours, and exostoses, with other growths of the same character, are unattended by the development or repetition of the disease in the glands. If cysts should coexist with malignant tumours, the glands may be affected with cancer; but cysts, as such, and cysto-sarcoma, are never followed by corresponding disease of the lymphatics. This fact is observed in the ovary, the os uteri, the kidney, the subcutaneous structures, the spermatic cord, sometimes in colloid, and, what is of the greatest practical importance, always in the female breast. My colleague Mr. De Morgan has at the present time under his care a middle-aged woman, whose left breast was the seat of an enormous innocent tumour, and the right of a well-marked scirrhous growth. The former tumour, growing rapidly, and threatening the patient with speedy death, was removed, and was found to be mixed cystic and adenoid, or chronic mammary. The right axillary glands were extensively cancerous; yet even with cancer thus existing in the body elsewhere, the glands in the left axilla were healthy. Some tumours, composed of structures unlike the part in which they grow, are not attended by disease of the same kind in the glands. An enchondroma of the femur, which I observed, though of vast size and fatal to life, was entirely limited to that bone. In the ischium also a cartilaginous tumour has been known to be unattended by lymphatic disease.* The same fact is commonly noticed in the enchondromata which grow in the fingers and the parotid region. The only exception to this rule of exemption of the lymphatics from secondary cartilaginous infection, is a case of enchondroma of the testis. Tortuous large vessels in the cord were found to be filled with adherent fragments of cartilage, and to lead to enlarged glands, and to a cartilaginous tumour of the size of an egg adjoining the inferior cava. An outgrowth of cartilage protruded from this tumour into the vein, and cartilage, carried perhaps in some form by the venous blood, was found in the pulmonary arteries. It might have been more accordant with the usual clinical progress of enchondroma if the cartilage in this case had been contained in, and had spread by, the spermatic veins; but the masses which it forms appear to be truly glandular enlargement of the cord, and they were, after long dissection, regarded as lymphatic by Paget, who recorded the case in the *Medico-Chirurgical Transactions*, vol. xxxviii. p. 247, and who refers to it in vol. i. p. 490 of the present work.* Fibrous, fibro-cellular, fibro-nucleated, and other tumours of heterologous composition, do not affect the glands; but when, though not adopting the structure of malignant disease, they assume its clinical characters, they may produce some moderate hardening and enlargement of the glands. Softening and a characteristic ulcer, with exuberant growth, never occur in these cases without true cancerous infection. Of myeloid tumours of bone, it is probably too much to assert that glandular disease is never a part of their natural progress, since, like medullary cancers, they are often amputated before the period at which the lymphatics would be involved. In some such cases, however, the disease has returned, and has been indistinguishable from cancer. Chronic abscesses in the substance of organs, such as are sometimes confounded with more important tumours, do not occasion an enlargement of the glands. An hydatid cyst may be covered with extremely large lymphatic vessels, yet occasion no plain disease of the subordinate glands. In an instance of a tumour in or near the female breast, which contained echinococci, and which had been suspected to be of malignant nature, the glands were entirely free from disease. A considerable enlargement of the inguinal glands took place in the course of a case of extremely rough gouty disease of the hip-joint, and was attended with œdema of the limb. The intercurrent glandular affection subsided during prolonged rest.

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* Bennett *on Cancroid*, p. 110.

Pyæmia is not attended with any specific inflammation of lymphaties, but there are a few general diseases in which those parts do share. These only of them, in addition to those which form the subjects of the present essay, may be mentioned: variola, vaccinia, typhus, plague, hydrophobia, glanders, and farcy. I would add a few remarks upon ulcers, erysipelas, and nævi.

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* "M. Velpeau a présenté à l'Académie de Médecine (séance du 28 juillet 1824) un encéphaloïde du testicule, avec des trainées cancéreuses le long du cordon spermatique, et un caillot d'apparence fibrineuse dans la veine cave, à quatre travers de doigt environ au-dessus de la naissance des deux veines iliaques. Le caillot était formée de matière encéphaloïde non ramollie." Kuhn, *Gazette Médicale*, 29 juin 1861.

Ulcers. The glands above old ulcers are often found enlarged, and, on some occasions, tender. In the case of chronic ulcers of the leg, the glands rarely claim attention, and little, if any thing, is known of the results to the glands from chronic ulcers of the bowel or uterus. But when an ulcer is situated near or connected with any form of tumour, an enlargement of the glands, such as may attend any ulceration, may mislead the practitioner into a conviction that the case is one of cancer. No judgment of a disease supposed to be cancer should ever be formed upon the ground of co-existent disease of the glands, without considering the amount of irritation of skin, and the character of any ulceration which may exist. Rest, a proper posture of the ulcerated part, and appropriate soothing or other treatment, will often cause an enlargement of glands to subside. I have known this to occur when the ulcer existed over a vast cysto-sarcoma of the female breast, and even when the primal irritation was an inflamed state of common carcinoma of the mamma.

Erysipelas. The exanthemata which extend over the whole integument of the body, as scarlatina and rubeola, do not perceptibly affect the lymphatics; but almost all limited inflammations of the skin are accompanied with some degree of tenderness or painful enlargement of the glands of the part. After blisters, upon the irritation arising from many surgical applications to the skin, in urticaria, in the cutaneous inflammation following an ordinary bruise, it is often met with, but it is by far most frequent in erysipelas. When that disease arises on unbroken skin, adenitis is an early, although a slight, symptom, and little noticed in comparison with the primary cutaneous eruption. But when erysipelas originates at a wound, the glands are sometimes swollen and tender before any blush can be discovered on the skin. They are stated to have been found red in an enteritis, which was recognised as erysipelatous;* and the almost invariable occurrence of adenitis at the commencement of the disease goes far to support the opinion stated in vol. i. p. 228, that the first inflammation of erysipelas is in the lymphatic system. In all cases except those treated of in the section on *inflammation of the absorbents*, the glandular affection is transient, and requires no special treatment.

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* *Gazette Médicale*, juin 7, 1856.

I have usually found some enlargement of the local glands in post-mortem examinations of cases of *Nævi* of the skin. The suspicion that some forms of nævi may be dilatations of cutaneous absorbents, not of the minute veins, has led me to examine the lymphatics in these cases; but I have never traced any unnatural communication of the blood-vessels with those bearing lymph. In all the fatal cases the patient had died in consequence of some operation on the nævus, and it was covered with more or less of an unhealed wound. No inference, therefore, could be drawn from the enlargement of the glands, which might have been connected with the open wound as much as with the nævus.

Morbid contents of lymphatics. Since it is a part of the healthy function of the absorbent system to receive the matters discharged into its radicles by the tissues, it happens that in disease also morbid substances find their way into it. Pus is frequently seen in the absorbent vessels of the pelvis in cases of fatal uterine inflammation. It was found, too, by Dr. Bright in tortuous lymphatic vessels, as large as iliac arteries, on the walls of a vast hepatic hydatid cyst.* Virchow† found still remaining in an axillary gland some cinnabar, which had been inserted by tattooing in the skin of the arm fifty years before death. Similar but less remarkable facts have been long known. Lapidaries have the lymphatic glands near the bronchi filled with earthy concretions, which are supposed to consist of inhaled stone-dust. Poncy saw the thoracic duct and its glands full of a cheesy substance. Perhaps the most common morbid material met with in this system, excepting strumous and cancerous matter, is some form of chalky concretion. Large masses of it may be found even in young subjects, whose glands have probably been early affected with scrofula. Assalini found it in the thoracic duct. Scherb saw a calculus in the same canal, and took it to be the cause of a dropsy. Cheston observed a thoracic duct so filled with bony matter, which had been absorbed from a spina ventosa of the ilium, that air could not be blown through it.‡ Some glandular chalky concretions in a young pig are stated by Vulpian to have been found tinted by madder, with which the animal had been fed.[*] Finally, it is asserted that worms have been discovered in human bronchial glands, as well as in the glands and absorbent vessels elsewhere.[†]

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* Guy's Hospital Museum.

† *Cellular Pathology*, translated by Dr. F. Chance, p. 185.

‡ *Phil. Trans.* vol. lxx. part ii. p. 323.

Obstructions and obliterations of the lymphatic vessels. When Mr., afterwards Sir, Astley Cooper tied the thoracic duct in the necks of some dogs, the receptaculum chyli burst, and a copious extravasation of lymph took place. A similar result is not observed in the human subject to follow the more slowly formed obstructions by disease. The museum of Guy's Hospital contains a specimen of a lacteal larger than a pullet's egg behind a diseased mesenteric gland. In the same museum is a thoracic duct completely compressed at its upper extremity by cancerous cervical glands. The duct is not at all dilated; but as there is another mass of cancer in its immediate vicinity near the pancreas, it is not improbable that the influx, as well as efflux, of lymph through it was hindered. Mascagni, attempting to inject some pulmonary absorbents, found the bronchial glands so obstructed that the mercury rather burst the vessels than traverse the glands. Sœmmerring, without accounting for it, relates the instance of a robust woman suffering from ankylosis of the knee, in whom the absorbents of the thigh were varicose, and so tensely filled that, upon being pricked, their fluid contents spirted violently forth, and that the foot was affected with a kind of œdema.

A *varicose* condition of a lymphatic vessel may possibly arise from another cause than its obliteration, contraction, or compression. There may be a regurgitation at the upper orifice of the thoracic duct, or there may be an accidental communication between an absorbent and a blood-vessel, an arterio-lymphatic or a veno-lymphatic aneurism. Such a case might be that of a thoracic duct, figured but unexplained by Cruikshank, in which the vessel is greatly enlarged and tortuous. Its diameter is nowhere less than four times its natural size, and, being increased in length as well as in calibre by the great power or weight of the stream within, it lies in many closely adjoining loops, which stretch to and fro across the vertebræ.

The *excision of glands* is now rarely practised, and more rarely still with intent. Occasionally a tumour is removed from the axilla or neck, which has been of long duration, and recently painful or inconvenient, and which is found upon excision to be a cluster of strumous glands, or a single one enclosing a little pus. Gross once removed from the neck of a middle-aged strumous woman a small chalky tumour, which proved to be a degenerated gland. But it is long since Surgeons have given up deliberately removing masses of strumous or merely enlarged glands with the knife. The large tuberous clusters of absorbent glands in the necks of scrofulous subjects seemed to invite that treatment; but when once undertaken it was found to be of formidable character, gland after gland presenting itself for extirpation as the more superficial were removed; and the operation was, consequently, often abandoned before it was completed, and rarely had any issue but that of early death by the development of phthisis in the lungs.

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[*] Potain, *Lésions des Ganglions Lymphatiques Viscéraux*, p. 33.

[†] Davaine, *Traité des Entozoaires.*

The extirpation of cancerous glands proceeds on the same grounds as those on account of which the primary tumour is removed. If the latter can propagate itself while connected with the body, so may the former; and although excision can never be advocated as a means of eradicating the constitutional affection, and obviating the recurrence of the disease elsewhere, yet it may be advisable, on the ground that the presence of any tumour must be regarded as insuring and hastening the general progress of the malady. It is not necessary to repeat in this place the facts and arguments by which this rule of practice has been supported in the essay on CANCER; reference on the subject can be made to it. The necessity of taking out the whole gland and the tissues surrounding it is absolute. It is not enough to open the tough fascial sheath, in which such glands sometimes become imbedded, and merely enucleate them. A clear halo of healthy structures should be removed with them. The difficulty of effecting this probably goes far to explain the fact, that little success attends the extirpation of the femoral and higher cervical glands, as compared with those in the axilla; and the cases are comparatively very few in which it is proper to attempt it in the groin and neck.

CHARLES H. MOORE.

DISEASES OF THE VEINS.

Adhesive Phlebitis.

JOHN HUNTER was the first to describe *inflammation of the lining membrane of veins.*[*] Aretæus[†] had long before referred to some such disorder; but the disease he described was so ill defined, that no one profited by or sought to advance his crude idea. Century after century Surgeons continued to puncture, divide, and excise veins, fearless of the result and innocent of their inflammation. Troublesome symptoms, it is true, sometimes followed these operations; but they were referred to nerves, tendons, or fasciæ—anything rather than the veins—to nerves more especially. "I was called in haste," says Ambrose Paré, "to see his majesty.[‡] He had been let blood by a Surgeon, and a nerve had been wounded in performing the operation, at which the king cried out with the pain. The arm became contracted, and the pain diffused throughout the entire limb. I applied a plaster over the wound to assure its closing, and bathed the part with warm turpentine and spirits of wine to allay the irritation, the arm being bandaged to the shoulder, and after a time the symptoms began to abate." Gangrene, he further states, may attack an arm after venesection, and may prove mortal. "I have known a lady to die," writes Dionis, "from diffused inflammation of the limb after a bleeding from the foot."

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[*] Phlebitis, so named by Breschet, from the word φλέψ (φλεβός), which was employed by Hippocrates to designate the channels which conveyed fluids, the term artery having reference to the air-passage alone. Thus, under the name of veins were included the various secretory canals, as the bile-ducts and the ureters; and hence Celsus wrote "a renibus singulæ *venæ*, colore albo, ad vesicam feruntur: οὐρητῆας Græci vocant" (*De Re Medicâ*, lib. iv.). Praxagoras first distinguished veins from arteries; for Aristotle, though he gave the name of aorta to the vessel which still bears that title, continued to write of it as one of the veins. See Galen *de Hip. et Platonis Dogmatibus*, lib. vi. c. 10; Galen *de dignoscendis Pulsibus*, lib. iv. c. 2; *Le Système veineux*, par le Docteur Verneuil, Paris, 1853.

[†] Κεφ. η'. περὶ τῆς κατὰ τὴν κοίλην φλέβα ὀξείης νούσου. Sydenham edition, London, 1856.

[‡] Charles IX. of France.

Paré, treating of varices,[*] observes: "sometimes in the limbs they contain a thrombus of blood, dry and hard, which, the vein being opened, should be evacuated." Petit writes a description of the formation of clots in obstructed veins, and of some of the changes they subsequently undergo.[†] Discussion was held respecting other clots or polypi (*polypes veineux*), as they were termed, which were found in the heart; and between Haller, Morgagni, and A. and J. Pasta, opinions differed as to the manner and time of their formation.[‡] Langswert wrote "de inflammatione venarum" in the section of his work, *De Morbis Arteriarum et Venarum compositis*,[§] but beyond the suggestive name made no advance upon the subject. Attention, however, had been thus drawn to the ill consequences which occasionally followed wounds of veins, and the formation of clots in their canals was recognised in connexion with varices and with obstruction.

Meckel, Frank, and Sasse followed Hunter in describing inflammation of the inner coat of veins; and from their time this disease (divided into the adhesive and the suppurative) has been amply illustrated by numerous observers, and by none more clearly than by Gendrin, who thus describes its morbid anatomy.[||]

He finds the inner tunic of an inflamed vein at first of a more or less deep red colour; but the evidence derived from this condition is often valueless from the attendant blood-staining. On separating the inner coat from the middle, which can be done more easily than in the healthy state, the injected capillaries become evident, even in the structure connecting the inner with the middle coat. After a while the inner coat becomes uniformly red, and is less transparent, so that vessels beneath are no longer distinguished. It has lost its polish, and even has become somewhat rough. It acquires, if the disease progresses, a swollen and villous appearance, and, but for its easily tearing, can be readily detached from the middle coat. The latter quickly thickens, so that the vessel resembles an artery, but is less resisting. The external coat is also affected and infiltrated with serum or blood. The cellular sheath becomes involved, so that the whole forms a blended blood-stained mass. A membrane sometimes lines the vessel, of little consistence, forming a cheesy pulp when pressed between the fingers.

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[*] *Œuvres complètes d'Ambrose Paré*, par J. F. Malgaigne, tom. ii. pp. 268 et seq.

[†] "Sitôt que le tronc des vaisseaux est entièrment bouché par le premier caillot, le sang qui remonte par les branches se coagule à mesure qu'il arrive, le tumeur augmente et devient plus dure." He then describes softening of the tumour thus indurated, which he ascribes to separation of serum from the clot: "c'est cette sérosité qui fait la mollesse." *Traité des Maladies Chir.* tom. ii. p. 42.

[‡] J. Pasta, *De sanguineis Concretionibus*, Bergami, 1786.

[§] Pragæ, 1763.

[||] *Histoire Anatomique des Inflammations*, tom. ii. p. 16.

Ribes, however, has observed it firm and resisting, and even organised, though but slightly adherent to the adjacent wall. Sometimes it adheres so firmly that it cannot be completely detached, and it occasionally covers a great extent of vein-wall, as in a case described by Chaussier,* in which the left renal and adjacent veins were thus coated. The blood now forms on the wall of the vessel fibrinous clots, more or less decolorised, by which the tube becomes blocked up. These clots are not formed at once, but "fresh fibrinous layers are continually being added, and in a proportionately very short time a plug is formed which fills the entire calibre of the vein."

"This fibrinous coagulum extends both above and below, far beyond the limits of the portion originally inflamed; the plug, however, ceasing by degrees to be made up of concentric layers, gradually passes into a tapering coagulum, more or less tinged with the colour of the blood, and little, if at all, adherent to the walls of the vessel. In all the branches of veins which immediately lead to the plugged portion, save those which have other channels by anastomosis, the blood stagnates and coagulates. The plug is shorter above, and seldom extends beyond the point of junction with the nearest venous trunk."†

Such is an account of changes which are said to accompany adhesive inflammation of veins. In a word, their inner and middle coats become inflamed, lymph is exuded upon and clings to the surface next the blood, the latter coagulates, and so the vein is filled partly with lymph and partly with clots. Then, as in every other inflammation, the mingled products undergo further changes.

It is, however, difficult to receive these statements in the face of facts which throw doubt upon the existence of an adhesive phlebitis. First, be careful, suggests Ribes, to distinguish all this redness of the lining membrane of veins from post-mortem congestion. Veins, after death, quickly become stained by the fluids adjacent, more rapidly in some cases than in others. Their discoloration is uniform, and, especially in small vessels, extends to the surrounding tissue, and this more particularly in the dependent parts "in inflammatory subjects from the ready separation of decolorised fibrinous concretions, in others from disseverance of the corpuscles."[*] Many have been misled by this discoloration, easy as its recognition may appear; for example, those who regarded phlebitis as the principal seat of erysipelas; and Ribes himself, when he wrote of an inflammation involving the roots of the portal vein of all persons dying with adynamic fever. Those also who assert that they have seen a phlebitis extending through many veins until it reached the heart, are equally deceived by this post-mortem staining.

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* *Revue Méd. française et étrangère*, 1825, tom. iii. p. 9.

† Hasse's *Path. Anatomy*, English trans. p. 14.

The experience of Guthrie,[†] who doubts the existence of an adhesive, or, as he terms it, a healthy inflammation of veins, is opposed to Gendrin's description; and Travers,[‡] whose statements, by the way, are contradicted by Bichat,[§] concludes that "the internal coat of a vein is, when compared with an artery, difficultly susceptible of adhesive inflammation. Indeed, the process of healing and division by ulceration seems to be conducted without any sign of inflammatory action; but the indisposition of the venous membrane to inflame is not, as appears to me, inconsistent with its tendency, under adequate excitement, to inordinate and excessive inflammation. It is not unusual to find the morbid action of parts that are difficultly roused least controllable when once set up." Frank and Sasse saw matters very differently. They observed a deep redness of the internal coat diffused throughout the vessel, and after ligature "a sort of false membrane, resulting from the inflammatory action."[||]

Cruveilhier[¶] observed that vascularity was not seen in the lining membrane of veins, even when the blood charged with irritants from inflamed parts caused an inflammation; for "I do not regard the phlebitis as the first change, but consider the coagulation as anterior to the phlebitis." Hunter[**] thought it difficult to conceive "how adhesions should take place on the internal surface of veins; since it is most obvious that the coagulable lymph thrown out by the exhalants on the internal surface of the vein, mixing with the same fluid circulating with the other parts of the blood, would be swept away without producing any effect. But since such adhesions do in fact happen, the coagulable lymph must undergo some change connected with the disposition which produces its extravasation."

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[*] Gendrin, op. cit. tom. ii. p. 5; Ribes, *Revue Méd. franç. et étrangère*, tom. iii. p. 5. 1825.

[†] *A Treatise on Gun-Shot Wounds*, 3d edit. p. 299.

[‡] *Surgical Essays*, part i. p. 255.

[§] *Anatomie Pathologique*, dernier cours, chap. xiv. p. 266.

[||] *Sylloge Opusculorum selectorum; Dissertatio Hallæ habita anno* 1797, p. 185. Also Frank, *Epitome de Curand. Hominum Morb.* lib. i. p. 187.

[¶] *Traité d'Anatomie Pathologique Générale*, tom. i. p. 290.

[**] Hunter, *Works*, vol. iii. p. 584.

Travers was the first to show that veins, after ligature or division, repair without an adhesive inflammation. Three preparations illustrate this fact. One, in the museum of St. Thomas's Hospital,* is thus described: "Appearance of a vein divided by the ligature, which came away on the twenty-fifth day. The upper part of the vein is filled with firm layers of coagula, which so tenaciously adhered to the inner membrane as to be separated with difficulty; when separated, the surface was found to be perfectly smooth and natural."† The second preparation shows the result of a ligature applied to the jugular vein of a horse for twenty-four hours. The inner vein-wall, thrown into longitudinal folds, is otherwise natural in appearance, whilst a good deal of lymph is accumulated externally around the ligature. The third, which, with the preceding, is in the museum of St. George's Hospital,‡ shows the effects of a ligature, including part of the parietes of the jugular vein of a horse. Some fibrine is deposited in the track of the thread and in a small pouch below, but no evidence exists of any inflammation of the lining membrane, and this three days after application of the ligature.

In the museum of St. Thomas's Hospital§ is a preparation of the jugular vein of a horse, with a circular aperture formed by ulceration of the wound made in phlebotomy. Its internal margin and the surrounding membrane is coated with adhesive matter. As in this case the interior of the vessel communicates with the tissues outside the vein, the adhesive material may have made its way into the vessel from diseased tissues which surround it. But, respecting this presence of adhesive material within veins, an error was originated and perpetuated by the experiments of Gendrin. "Should any imagine," writes Hasse, "this false membrane to be not the product of plastic effusion from the coats of the vein, but an immediate deposit from the blood, let him refer to the experiment of Gendrin. Having secured a portion of an artery between two ligatures, and entirely cleansed it of blood, that experimentalist discovered, after throwing in an irritant injection, a plastic membrane deposited within the part so insulated, filling up the whole calibre of the vessel; and he affirms that similar results followed in experiments upon veins." Notwithstanding the credit this view long obtained, and the support it received from authorities in this country, its accuracy was disproved by Lee. Having found that inflammation of the coats of the veins only occurred when the blood had previously coagulated in them, he was induced to believe that the deposit found in the veins might be derived directly from the blood. Gendrin's experiment was, therefore, repeated; and when precautions were taken to exclude all blood from the vessel, no lymph was effused in the vein.

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* Series Y, 151.

† Travers, *Surgical Essays*, plate xiii.

‡ Series xii. subseries 2, 1, and 7, 1.

§ Series Y, 152.

In repeating this experiment, I find, however, that lymph is occasionally found within the veins, but that its presence is due to an effusion external to the vessel. The precaution of closing, by ligature or otherwise, the opening through which the irritants are introduced, effectually secures its absence. The following experiments show the result as this precaution is, or is not, taken. They show that the lymph, when present, finds its way into the vein from without, and is not exuded from or through the lining membrane. Neither, in animals, does the internal coat inflame when irritated.

1. Part of the femoral vein of a dog being selected, free from anastomosing branches, a ligature was applied so as to stop the blood coming from the extremity. The vein was then opened by a longitudinal incision, and the blood in the vessel was removed A second ligature was then applied between the longitudinal cu and the first ligature, and a third was tied between the wound an the heart. After twenty-four hours, lymph was found in the latte interspace, but not in the first. There was also an abundant deposi of lymph external to the vessel.

2. Part of the femoral vein of a dog having been include between two ligatures, was punctured, all blood removed from it interior, and two small pieces of lead introduced within the portio of the vessel isolated by the ligatures. Twenty-four hours after th operation the vein was surrounded by lymph, a considerable quan tity of which had entered the vessel through the puncture disten ing its canal, as may be seen in the preparation.

3. The femoral vein of a dog having been exposed, an exper ment was made which resembled the preceding; but the ligatu nearer the heart was shifted after introduction of the foreign bodie so as to cut off the portion of vein in which the pieces of lead we included from communication with the puncture in the wall of th

vessel. The lining membrane of the portion of vein thus isolated presented a natural appearance twenty-four hours after the operation.

4. A small piece of lead was introduced within the femoral vein of a dog, and there suspended by a thread, as seen in the preparation. The puncture in the vein-wall was then closed by a ligature, which had the effect of slightly narrowing the canal of the vessel. The blood was then allowed to flow through the vein for forty hours. At the end of this time the lining membrane of the vessel retained its natural appearance.*

From these considerations it is manifest that adhesive phlebitis has been very variously described and accounted for, and that its occurrence has been denied by some pathologists. There can be no doubt but that veins are repaired without its aid, and experiments upon animals, taken for what they are worth, show that these vessels do not inflame when irritated. Absence of vessels from their lining membrane points, one would think, a reason for this immunity. A tissue thus circumstanced may eventually be involved when adjacent parts are affected, but it does not originate disease. As the barrier between tissues often inflamed on the one hand, and the blood-stream on the other, it would obviously discharge an important function did it prevent lymph from being effused on the internal surface of the vein. For although this lymph might be swept away without producing any local effect, it could not be mingled with the blood without risk of spoiling that fluid, or of causing secondary mischief by becoming entangled in, and so obstructing, the capillary vessels.

The subsequent account of phlebitis will differ somewhat from the description usually given, first, because the occurrence of this inflammation of the lining membrane is more than doubtful; and secondly, because many cases which would otherwise have been treated of as phlebitic will be here referred to the simple process of coagulation of blood within the vessels,—a subject which has only of late years attracted the attention it deserves. These cases may be best disposed of before the description of phlebitis is resumed.

Thromballosis.

The changes which result from *coagulation of blood* within the veins (thrombus, as Petit terms it†) may easily be mistaken for processes of an inflammatory character, unless the beginnings of the disease are accurately observed.

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* Museum, St. Bartholomew's, series xiii. 156.

† Also named *embolism*, from ἔμβολον, a plug. The term *thromballosis*

Causes. As it has been elsewhere shown* that the blood-fibrine, under certain conditions, is apt to coagulate spontaneously within the vessels, it will here suffice to recal the fact. Coagula may indeed form, as a means of repair, be the blood condition what it may. They do so in arteries after application of a ligature. They do so in veins when wounded or when torn across, and are then sufficient to close the rent, and eventually to repair it. In these cases the coagula are limited in their extent. But in other cases, and to these our attention is now directed, when a clot is formed within a vein, it increases and extends from one to another, until having commenced perchance in a vessel of small size, it reaches and fills the largest.

This remarkable tendency of the fibrine to coagulate within th veins may exist, unsuspected, in the ill-nourished and feeble, o may be slowly induced during the progress of disease. Som trifling circumstance is then sufficient to call it into action. Bouillaud states† that those dying from phthisis or from cancer ofte suffered from the formation of clots in veins. In one case the external iliac was thus filled with a coagulum where compressed b intestine distended with fæces. In another, a tumour pressed th vena cava; in a third, a cancer growth the internal iliac; an where the pressure fell, there each vessel was closed by coagulum. In the body of a young man who had long lain in one of the ward of St. Bartholomew's Hospital with his thighs drawn up on th abdomen, the femoral veins were closed by clots above the junctio of the profunda, and as high as Poupart's ligament. The mere fle ing of the vessels had sufficed to determine the coagulation, as h slowly died with phthisis of the lungs.

The circumstance which called the coagulating predispositi into activity, seems, in these cases, to have been the pressure up the vessel. So again in the following case. On December 6t 1860, I examined the body of a male patient who had long suffer

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more correctly indicates this disease (θρόμβος, a clot, and ἀλλοιόω, change).

* Vol. i. p. 270.

† *Traité clinique des Maladies du Cœur.* Bidault (*Recherches sur les C crétions sanguines des Veines*, Paris, 1850) states that Legroux first drew att tion to the spontaneous formation of clots in veins.

‡ See cases by Forbes and Holberton in *Med.-Chir. Trans.* vol. x p. 293, vol. xvi. p. 62; also museum, Guy's, 1523^{50}.

from dilatation of the pelvis of the right kidney, in consequence of impacted calculus. Pericarditis was the immediate cause of death. The vena cava inferior was compressed by the dilated pelvis (which formed a cyst holding four pints of fluid), and was somewhat narrowed above the junction of the common iliac veins. The right common iliac was filled by a coagulum in part soft and blood-stained, decolorised where in contact with fluid blood coming through the opposite vein. It extended far towards the leg, even to the veins about the middle of the thigh, and the right lower extremity was œdematous.

In these cases, the pressure is often slight, and generally acts upon one side of the vessel, the vein being free to yield in the opposite direction. They must be distinguished from those cases in which the pressure is made upon the whole circumference of a vein, or if acting on one side, compresses the vessel against a resisting substance such as bone. The vein is then filled with a coagulum distinct or mingled with an ingrowth from any tumour which may happen to surround it, and eventually, if the vessel become obliterated, clots form on the distal side of the obliteration, just as after application of a ligature. This occurred, for example, in the case of a woman, aged twenty-three years, who suffered from osteoid cancer, involving the lower part of the left femur and the popliteal space. The limb was amputated at St. Bartholomew's Hospital. The diseased portion was examined Nov. 23d, 1861. The popliteal veins, there were two, were obliterated, and could not be traced amidst the substance of the tumour; but above and below the obliterated portions the vessels were filled with firm colourless coagula.

Other circumstances, however, more often determine the formation of coagula, and give opportunity for their subsequent extension. 1. Inflammatory changes in the tissues which surround veins. Thus at the base of an extending ulcer the veins are filled with coagula.* Ever, as the disease advances, the clotting goes before, and plugs portion after portion of the adjacent veins. Rendered solid, they may indeed soften and slough as the disease progresses, but hæmorrhage is, as a rule, prevented by their previous obliteration. 2. Laceration of a vein, as when the placenta is expelled from the uterus. Some blood escapes and coagulates without, and some, but not much, within the vessel, which is itself contracted.

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* Museum, St. Bartholomew's, series xiii. 61; Middlesex, vi. 52; St. George's, series xii., subseries vi. 1, 2, 3.

Thus, and by subsequent changes, the vein is permanently closed. The extension of clots, which results in either of these circumstances when the predisposition inclines to it, though of common occurrence, has received scanty attention.

In illustration, I will narrate two or three cases. In the body of a man brought to St. Bartholomew's for dissection, death having resulted from phthisis, the nates were covered with sloughing sores. The left femoral, just below Poupart's ligament, was filled with a firm coagulum, which ascended to the junction of the epigastric vein. Attention was drawn to numerous veins about the base of the sloughs, which were more than usually conspicuous from being distended with clots. They converged towards and formed the left internal circumflex, and so extended direct to the femoral; and, without doubt, accounted for the clot which had formed there in direct continuity with those in the smaller vessels.

My friend, the late Dr. Baly, sent me the following report of the case of a female aged sixteen years, a prisoner in Millbank. On the 20th January 1844, she was placed on the sick list. She was of a strumous aspect, and had suffered from attacks of diarrhœa and of dysentery, attended with pain about the head and cramps. The day following, the cramps ceased. Pain and tenderness about the epigastric region persisted. The third day she began to complain of pain in the right side of her head, and the right side of the face was slightly swollen. The gums were somewhat affected by mercury she had taken. A glazed red streak extended from a pustule on the right side of the nose to the inner angle of the eye terminating abruptly. A good deal of pus had discharged fron the pustule during this and the preceding day. The fourth morning she was seized with convulsions of an epileptic character. Sh became insensible, and on the fifth day she died. The body wa examined twelve hours after death. The right cavernous sinus wa filled with clots and puriform material, as also was the ophthalmi vein. Elsewhere, each sinus contained dark fluid blood. Tw veins, one from the dura mater, the other from the brain, wer filled with clots. The vein by the side of the nose also containe coagula. Part of the brain lying over the cavernous sinus wa ecchymosed, the blood was coagulated in its vessels, and its tissu softened. From the pustule to the softened brain tissue the progress of the disease was distinct, and not to be mistaken.

If examples are required to show how veins, after wounds an rupture of their walls, become obstructed with clots, they may b taken from those cases of œdema of the legs, so often following par turition, bad fractures, and even severe contusions. On July 19th, 1855, a woman, aged twenty-four years, was admitted into St. Bartholomew's Hospital, who had enjoyed good health until, about six months before, she had fallen from a height, and severely bruised herself about the pelvis. Two months after, she was confined at the full time. A few weeks before, she had noticed some swelling of her legs, and she subsequently suffered from obscure abdominal pains, with occasional hæmorrhage from the vagina. Her emaciation became extreme. The lower etremities became permanently œdematous, and hard cords could be traced along the course of the principal veins. Exhausting diarrhœa baffled treatment, and, sinking gradually, she died about eight months after her confinement. The femoral and all the iliac veins being removed after death, presented the following appearances. In places they were greatly distended, firm, and resisting. Between such portions they were contracted and empty. All smaller veins opening into these trunks were occupied by firm, decolorised clots. The tissues around were natural, save about the femoral veins, where they were somewhat thickened. The coagula clung pretty firmly to the walls of the vessels; they showed an arrangement of concentric layers, easily separated one from another. At the contracted points, the walls, as elsewhere, presented a natural appearance. All other parts of the body, excepting the œdematous legs, presented a natural appearance.

Again: a woman, aged sixty-two years, died in the same hospital, forty days after a comminuted fracture, from direct violence about the upper and middle part of her right femur. Her death resulted from exhaustion; she sank gradually, with extensive bed sores. The right lower extremity was slightly œdematous. Great ecchymoses were found about the adductors and the vastus internus. The profunda and its formative branches were plugged as high as the junction with the femoral vein with softening blood-stained clots, of the existence of which there was no suspicion during life. The fractured femur remained ununited. The relation between these clots and the occurrence of non-union will call for subsequent remark. The predisposition which inclines the blood to form these continuous clots is thus called into activity by accidents of common occurrence.

The coagula extend in all cases in one of two directions—(*a*) against, (*b*) with, the blood-stream. To assist in explaining their extension, the formation of a coagulum in an artery on which a ligature has been tied, must be referred to. It is thus noticed by

Jones: "From these circumstances it appears that the enlargement of the portion of the artery between the first collateral branch and its extremity is prevented; but it is obvious that there must be a small quantity of blood just within the extremity of the artery, and which is more or less *completely at rest*; it *therefore coagulates*, but does not appear in every instance to form a coagulum capable of filling up the canal of the artery; for, as may be observed in many of the experiments, several hours after the artery had been tied, there was only a slender coagulum formed in its extremity. I am therefore disposed to think that though the artery cannot accommodate itself to the blood determined to it, yet it undergoes such a degree of contraction, as occasions too much motion in the blood which it contains to admit at once of its complete coagulation. It is a fact, that in most cases only a slender coagulum is formed at first, which gradually becomes larger by successive coagulations of the blood; and for the same reason it is that the coagulum is always at first of a tapering form, with its base at the extremity of the artery."* The researches of Stelling† add little, if any, information. He observes, that the arrested blood forms a conical mass, whose apex is near the first lateral branch, and whose base is seated on the extremity of the vessel, and is contained within a funnel of blood in partial motion.

Now respecting this coagulum (thrombus) two facts deserve to be noted. The first is its formation independent of the division of the middle and internal arterial coats. For if a broad ligature be tied round an artery so as to close its canal without lacerating the coats, a clot is readily formed between the ligature and the first branch on the cardiac side.‡ The second fact is that the blood is not stagnant above the ligature, that is to say, in a state of rest, as is usually assumed. On the contrary, it is agitated in an orderly manner, so that the fibrine is as it were churned out of the blood to form the coagulum. This may be illustrated by the following experiment. Let an opening (*a*) be made in the side of a common glass test-tube. Between this opening and the closed extremity of the glass let the latter be filled with sand. A stream of water directed through

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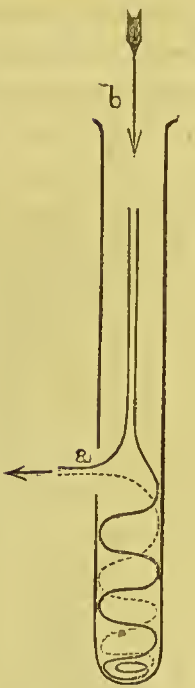
* *On Hæmorrhage*, p. 159. See also Halleri op. min. t. i. exp. 54. "Sensim vero de arteriâ ligatâ sanguis collectus ita refugit ut nullus supra vinculum sanguis maneret, sub lino vero copiosior et stagnans superesset."

† *Die Bildung und Metamorphose des Blutpfropfes oder Thrombus in verletzten Blutgefässen*, Eisenach, 1834.

‡ Museum, St. Bartholomew's, series xiii. 141.

Fig. 1

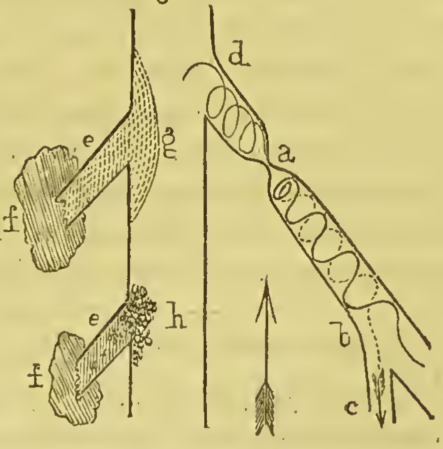


an elastic tube adapted to the orifice (*b*) of the glass will quickly remove the greater part of the sand through the lateral outlet (*a*). What remains will assume a spiral shape, whilst the particles of sand as they are whisked away will indicate a spiral movement of the water-stream, as shown by the plain and dotted lines in the annexed diagram. As the relations are varied between the velocity of the stream, the diameter of the outlet, the diameter of the tube, and the distance between the closed extremity and the lateral opening, so of course will the result be modified.

In the midst of such an orderly movement, fibrine is probably separated from the blood above a ligature and forms the clot, which, moulded by the blood-stream, is spiral and conical, extends to the first lateral branch (where the churning movement ceases), and, consisting of separated fibrine, is from the first colourless.

Under like circumstances, clots form and extend in an obstructed vein (fig. 2, *a*) in opposition to the stream as far as the first branch, as at *b*, where the blood turns back through the collateral vessel (*c*); they also form where the blood regurgitates, as in the subclavian vein from disease of the heart;* but these coagula are produced less rapidly than in arteries, and their fibrine is often largely mingled with other blood constituents. The blood also finds its way into the vein on the cardiac side of an obstruction (*d*), and supposing vessels (*e e*) to be torn across, what with an external clot (*f f*) and the coagulation within, as at *d*, they are soon plugged to their junction with a larger vessel. The end of the clot in contact with the blood-stream is round or flattened, if in a small vein which opens into one of large size; if, on the other hand, it occupies the large vessel, its extremity, moulded by the lateral current, is tapering, or otherwise

Fig. 2



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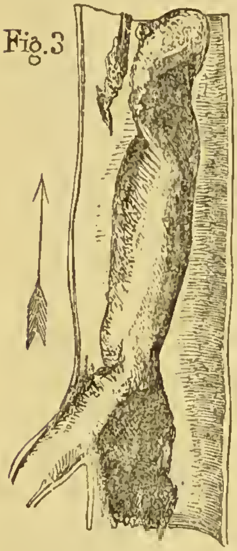
* Museum, Guy's, 1521^{30}.

modified in its shape.* Beyond any such point the extension of the clot in predisposed cases depends, as shown by Virchow, upon deposits from the blood as the latter flows over the coagula, and these additions of fibrine may be arranged in orderly layers (*g*), or may be deposited irregularly, leaving a rough surface, as at *h*.† By these accumulations the largest veins may be so nearly occluded that a slight additional coagulation at any moment completes their closure. Vessels thus plugged present the appearance shown in fig. 3, drawn from an obstructed profunda vein, the yellowish or white clot, having as is usual a spiral shape, and the coloured coagulum filling its interspaces (often speckled with fragments derived from the fibrine masses), the whole bearing below an impression of the vein-valves.

Fig. 3



The several changes hitherto described, although as often independent, are frequently associated with ordinary inflammation of the parts around, as may be seen in the greater number of the preparations in the London museums. As a consequence of such inflammation (misnamed adhesive phlebitis), the small vessels quickly fill with clots; and if a main trunk be then examined, its inner surface will be found dotted over with what at first sight look like plates of lymph, but which are in reality the clots projecting from the branch veins, some firmly attached, some hanging loosely in the canal. From these, as starting points, the main vein becomes in turn obstructed with coagula, more especially if its outer walls are implicated in the inflammation, the clots having often a regular laminated arrangement. At the first large vessel which joins the affected vein the clotting is arrested by the incoming blood-stream; but if, as has been already shown, the disposition to clot-formation is strong, it is only checked at the junction of collateral vessels, and may extend with scarcely any limit either towards or away from the centre of the circulation.

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* See woodcut, vol. i. p. 275; also museum, Guy's, 1521^{22}; Middlesex, vi. 52.

† It is from these projecting coagula that fragments and even large masses are separated, pass into the blood-stream, and are carried by it to be eventually lodged in distant organs. Several cases are recorded in which sudden death has been caused by the lodgment of such a fibrine mass in the pulmonary arteries; the consequences of their arrest in the arteries of the brain, whither they are usually carried from deposits on diseased valves of the heart, have been fully investigated by Kirkes; and the whole subject of occlusion of the arteries from this cause will be found treated of in the following essay (pp. 332 et seq.). Plate viii. attached to Davis's paper in *Med.-Chir. Trans.* vol. xii., and preparation 1521^{22} in Guy's Hospital museum, are excellent illustrations of coagula in a position to be thus washed off by the blood-stream.

When these clots are removed, the lining membrane of the vein beneath presents a natural appearance; but its outer and middle coats are not unfrequently thickened, and if there be much contraction of the tissues around subsequent to their inflammation, the vein may be thrown into longitudinal folds, or may become tortuous.*

As each coagulum is formed, it *contracts;* and it often happens, being firmly fixed by its roots, as we may term its prolongations into the small branches, that the vein-wall is drawn with it in its retraction, becoming condensed and thickened in appearance, so much so that when cut across it resembles an artery. Indeed this condition is generally mistaken for an inflammatory thickening of the vessel; but in the case of the young woman narrated at page 293, suspecting the nature of the change, I removed the internal saphena, which was contracted, thick, and hard like a piece of whipcord, and having injected water into a part of the vessel, easily restored that portion of the canal to its ordinary size and the vein-wall to its usual appearance, so that in the preparation† it forms a marked contrast to that part of the vessel which remains condensed. Had its walls been thickened by any inflammatory deposit, they would not have yielded to the slight pressure which was employed.

Sometimes the coagulum shrinks to one side, being more tightly held by the branches in that than in the opposite direction, and under favourable circumstances the blood, incessantly endeavouring to insinuate itself into the obliterated vessels, may form a channel by the side of the clot between it and the vein-wall, or in rare instances (referred to by Ribes and others) may drill for itself a passage through the centre of the clot. Under such circumstances the circulation is reëstablished, though still hindered by portions of fibrine, which form bands and cords stretching across the canal.‡

It more commonly happens that the obliteration is permanent and the vessel is lost to the circulation, the clot (frequently organised) and the vein ultimately forming a firm, shrunken, sometimes calcareous, cord. The collateral circulation carries off the blood which should have passed through the lost vessel; though, before this is established, and even after, there is œdema of those parts from whence the return of blood is hindered, and occasionally even hæmorrhage. The extent and severity of this œdema (*white swelling*) will depend, (*a*) upon the size of the vein obliterated, (*b*) upon the extent of the obliteration, and (*c*) upon the sufficiency of the anastomosing vessels to remedy the obstruction. When the œdema is attended with considerable pain, a low state of inflammation is superadded. The part is swollen and hard, but does not pit on pressure, as in anasarca, and is not red, as in phlegmonous erysipelas. But these affections are nearly allied, as the one causes cellular inflammation, and erysipelas itself almost always occasions an affection of the veins.

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* Museum, College of Surgeons, 1725.

† Museum, St. Bartholomew's, xiii. 157.

‡ Museum, St. Thomas's, Y, 162, 168.

This œdema often embarrasses the *repair of fractures*, more especially when the breakage is near a medullary foramen and involves the laceration of a large vein, or when the tissues around are greatly bruised from the direct violence of the injury, so that clots form in the principal vessels. As this complication is of such common occurrence, it is strange that attention has been so little directed to it in cases of tardy or non-union. It may be suspected when, about the fourth week after the injury, the parts continue or become œdematous, cold, and often aching. The remedy consists in endeavouring to improve the circulation through the superficial veins, which are least often obstructed, by friction with the hand and by position. It is, however, always a serious affection, as shown by the frequency with which opportunities offer for inspecting the bodies of old and feeble people who die some weeks after a fracture with no trace of union, but with numerous ecchymoses and plugged veins around the seat of injury.

It just depends upon the goodness or poverty of the fibrine whether it shall cause these simple obstructions, or whether it shall *soften* and *disintegrate*, forming a thick yellow fluid, sometimes blood-stained, which resembles pus (puriform) in its appearance, and which, with the complications it may give rise to (pyæmia), has been already described.* The portions of clot when softened are usually shut off (sequestered) in an upward and downward direction by newly added coagula. And here I may observe, that the softening begins, as a rule, in the coagula last formed, not, as Virchow states, in those first deposited. For in the advance of the malady the patient's failing condition begets an associated poorness of the fibrine; so that a disease begins with fibrine, which will form and continue a firm compact plug, but ends with deposits of a worse material, which rapidly disintegrates and softens.

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* Vol. i. p. 289.

The symptoms of obstruction of the deep veins are very obscure, even when attended with ordinary inflammation of the parts around. There may be some constitutional disturbance; the superficial veins may be congested, and after a time the occurrence of œdema may be noted. When the limbs are affected, they feel hot and dry, are usually flexed, and cannot be extended without considerable pain. If the superficial veins are involved, they can be felt as hard cords under the finger, the induration being due to the thickening of the tissues around, to the clots within, or, more often, to the two conjointly. The course of the attendant inflammation is marked by redness and tenderness, and may be distinguished from inflammation about the lymphatics by the minute size of the cords in the latter, its superficial character, the numerous small knots, and the rose-coloured redness of the skin. The diagnosis between affections of the deep veins and of the absorbents is not so clear. An accompanying injury, from which the mischief may have started, and which is generally a contusion or an open wound of some kind, will usually suggest to us the probable condition of the neighbouring veins.

In many cases no danger is to be feared; but when large and important veins are extensively affected, as those of the pelvis and lower extremities conjointly, nutrition is so largely hindered that death by no means unfrequently results. The obstructions often cause serious complications, as has been already shown; and then there is further danger from portions being separated from the clots in the veins, and carried to cause secondary mischief in the capillaries of various organs (pyæmia).

If the nature of this affection is rightly understood, the description of its *treatment* becomes simple enough. The patient's health must be upheld by full doses of bark, or of any other approved tonic; and a generous diet must minister to his amendment. If there be any error, it will be on the side of not doing enough in this respect. Locally, rest must be insisted upon, if possible in such a position as shall favour the circulation through the part affected. The circulation should be promoted in the superficial veins, as has been already indicated, as the surest means of relieving the œdema. If there be pain from an inflammation, it may be soothed by warm fomentations; if it be chronic and from œdema, it is useful to give opium in some form, and thus for the time relieve it. Each case in which the symptoms are at all serious will probably require patient watching; for the disease, with its series of stages, the coagulation, the eventual obliteration and the righting of the circulation, is of slow progress, and must, after all, be left pretty much to nature. Our anxiety to render assistance should never lead us to the employment of such remedies as blisters applied to the œdematous limb; nor can aught but harm be anticipated from depletion, the use of mercury, or of such-like powerful medicine. Except in the several cases to which I have referred, a favourable issue may be anticipated.

Suppurative Phlebitis.

It remains for me, having already noticed the adhesive, to describe the *suppurative* (diffuse) *phlebitis.* This disease is, in fact, nothing more than a diffused phlegmonous inflammation, and ought to be reclassed with disorders of that character, from which it was separated on account of a prevalent opinion that the inner membrane of veins was the part first and chiefly affected. This inflammation follows the course of veins which, acting as conductors, favour its rapid extension in the direction of least resistance; and hence, as a rule, the disease passes from the small to the larger vessels, since the cellular surroundings of the latter offer the easier route for its advance. That the parts around are first affected, and not the lining of the veins, is not only shown by the examination of fatal cases, but is the more reasonable a proposition, since it does away with the difficulties which surround the history of an inflammation of the internal and middle coats. There is no preparation of so-called suppurative phlebitis I am acquainted with in which the parts around the veins are not inflamed and thickened.

No patient in decent condition of health could suffer from this disease. The worst they could be troubled with would be a limited (adhesive) inflammation of the parts around the vessels, with attendant obstruction of the veins with clots. But if the system is depressed and enfeebled, as when suffering from extensive ulcers, from large lacerations, or from severe operations, this disease, attacking wounds and adjacent structures, extends along the course of the vessels, just as in other cases it happens to extend along the subcutaneous cellular tissue, and is known as phlegmonous erysipelas. It succeeds after various and dissimilar modes of local irritation; in one case, the puncture (venesection), in another, the division of a vein, is its starting point; and it often occurs after amputations, as after other wounds; not, however, in consequence of ligatures applied to veins after any such operation. Whether these vessels be tied or not, this inflammation may supervene; indeed in every amputation, as remarked by Blandin,* the veins which accompany small arteries are always tied; and we have no right to argue that the ligature of a large vein is more likely to be followed by diffused inflammation of its wall, than is that of the smaller vessels. Such an assumption cannot be justified. Moreover ligatures separate from veins, as already shown, without exciting inflammatory changes.

Whilst remembering that various degrees of severity exist between the limited (adhesive) inflammation of the tissues around a vein, and the most severe form of diffuse suppuration of the same structures, we will take a bad case of the latter as giving a correct idea of the nature and progress of the disease.

On March 27th, 1861, I examined the body of a man who died in St. Bartholomew's Hospital under the following circumstances. He fell from a height, and so upon some iron spikes, which penetrated one into either thigh. Diffused inflammation became established along the track of the wounds, more especially on the right side. On the fourth day, without material aggravation of the symptoms, the right saphena vein became indurated along its entire length. The lungs became congested, symptoms of dyspnœa were added, and he died (typhoid) on the seventh day. The right wound extended across the thigh to its inner side, and unhealthy pus was diffused far and wide superficial to the fascia lata. The tissues around the saphena vein were laden with extravasated blood, and with unhealthy sanious pus. The glands, especially about the upper part of the thigh, were enlarged and blood-stained. The outer coat of the saphena was œdematous, the internal surface of the vessel was rough, and the inner coat was, for the most part, wanting. There was no increased vascularity of the vessel. Its canal was filled with sanious pus, and occasional shreds of blood-clots. Just above the inner ankle it was suddenly contracted, and contained a tapering coagulum; and here was the limit of the surrounding inflammation. The femoral vein, at its junction with the saphena, was laden with soft coloured clots, which extended into the external iliac. The lungs were congested and œdematous.

The changes in this and in allied cases may be described as an infiltration of the tissues around each vein with serum and corpus-cular lymph. This quickly degenerates, and forms a series of abscesses, or rather a diffused collection of pus. The rapidity with which these results follow each other is most alarming. The veins at first contract, entangling, as they do so, some few coagula; but presently such portions dilate. Beyond these, other parts of the same vessel are undergoing, as the surrounding disease advances, the earlier process of contraction; and again, beyond such portions, clots close their canal and mark the momentary limit of the disease. And so it extends, following the vein-course. All branch vessels are closed with clots, or involved otherwise in the disease, so that no blood flows through the vessel, and thus and from the condition of the parts around, no nourishment can now reach the inner vein-coat, so it dies, becoming cloudy, forming an inorganic friable pulp, which gradually melts down until no vestige of it remains. The inner coat being destroyed, pus may find its way into the dilated vessels, either direct from the other vein-coats, or through them from the parts around; for these coats, deprived like the inner of their blood-supply, frequently perish in the course of the disease.

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* *Journal Hebdomadaire*, Paris, 1829, tom. ii. p. 579.

The symptoms which accompany these changes are of a low, even typhoid character, ushered in with rigors, and a general increase in the severity of preëxisting signs. If superficial veins are involved, the accompanying induration and congestion of the parts around will mark the progress of the disease; if the deep vessels are implicated, it is upon the accession of general symptoms, and upon the uneasiness about the parts affected, that we must rely for a diagnosis, which indeed is not always easily arrived at. When satisfied that diffuse suppuration is established, we can have but faint hopes of a satisfactory issue, although in the less severe cases we may succeed in limiting its extension, and so in arresting the disorder.

To effect this, every effort must be directed to the support of the patient with stimulants, good *animal* food, and tonics; warm fomentations applied to the parts affected, must be combined, if possible, with free incisions to allow of the escape of the unhealthy material depositing along the course of the vessels. But enough has been said in treating of erysipelas and of pyæmia, to render it unnecessary to enter here into details of management, which would be merely a repetition of those recommended for the diseases aforesaid.

In the cases of diffuse suppuration, the coagula play an unimportant part, very different from the position they occupy in cases of clot-obstruction, more especially when they soften and acquire the puriform condition. Enough, I trust, has been said to enforce the importance of distinguishing between the two affections. Careful examination of individual cases will prevent their being hastily confused the one with the other; indeed in these, as in all other cases, no just conclusion can be arrived at without accurate observation and the exercise of an unbiassed judgment.

Unlike as the two diseases may be, they have, however, this in common, that either may be the cause of those secondary complications to which the term *pyæmia* is properly restricted.

Infants occasionally suffer from inflammation about the umbilical vein, as noticed by Osiander, Meckel, and more recently by Duplay.* It commences from the second to the twelfth day, and is often preceded by some injury which the child has sustained. In other cases, it would seem to depend upon influences the same as those causing puerperal fever and allied disorders. Duplay found in three out of six cases that erysipelas was associated with the affection of the cord; and occasionally even local gangrene occurs, thus showing the low phlegmonous character of the affection. The general bad condition of the children is also indicated by discharges from the mucous membranes, and by the coöccurrence of purulent ophthalmia. Death occurs from the twelfth to the sixteenth day. The entire cord is involved, thickened, with the structures around, and often with peritonitis. The umbilical vessels are all obliterated in the common affection, their canals being filled with clots, which have been found to extend into the portal veins. The diet of the child and the various secretions require attending to, and warm fomentations may be applied to the inflamed structures; but the tender age of the infant is unequal to resist so serious a disease, for a fatal result has followed in all recorded cases.

Some veins not infrequently contain loose *calculi* or phlebolithes, generally round or oval, and sometimes attached by a narrow pedicle to the inner wall. No inconvenience results from their presence. They are found most frequently in the veins of the pelvis about the bladder and prostate, especially when the latter is enlarged.

Their origin has been much questioned. Bichat† thought that they occurred in veins exposed to slow circulation of their contents. Hasse found them connected with varices. Hodgson‡ held that they were probably formed in surrounding parts, and made their way into the veins by absorption. Cruveilhier stated they were developed in the centre of a clot of blood. It is, however, most probable that they are clots which have thus dried up and become transformed. Having protruded from some small branch, they receive additions to their surface, and, eventually separating from the pedicle which held them to their original vessel, shift their situation, and are perhaps rolled along for some distance by the blood-stream before being finally arrested.

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* *Revue Médicale*, 1838, tom. iii. p. 104. See also Morgagni, *Epist. Anat. Med.* liii. art. 37.

† *Anat. Gén.*, par Béclard, p. 104.

‡ *Dis. of Arteries*, p. 511.

They are formed of concentric layers, which consist, according to an analysis kindly made for me by my friend and colleague Dr. Frankland, of protein matters and phosphate of lime. The former, constituting about twenty per cent of the calculi, are nearly all albuminous or fibrinous; the latter, though mainly phosphate of lime, is mingled with a little sulphate of potash and sulphate of lime. That is to say, the phlebolithes consist, as might be expected, of the coagulated protein constituents and the less soluble salts of the blood.

Hypertrophy and Atrophy.

Hypertrophy of veins occurs when any part of the body is the seat of increased growth. It is a natural and healthy change. Thus during pregnancy the uterus is provided with enlarged channels for the removal of its venous blood; and thus in a case of medullary cancer of the omentum I have seen the portal vein twice its natural size, in consequence of the large quantity of blood carried to it from the rapidly-growing tumour.

With this form of hypertrophy there is proportionate dilatation, so that the vessels are perfect to perform all their functions. They are thus adapted to new conditions, as when an artery is wounded through a vein, and the latter dilates (aneurismal varix) above and below, its walls becoming thickened so as to resist the arterial impulse.

Hypertrophy with dilatation also compensates for many obstructions to the circulation by fitting one set of veins to make up for the loss of any other. Thus no inconvenience follows when superficial veins are obliterated, for by dilatation of anastomosing branches the circulation is readily reëstablished. When the vena cava inferior even is permanently closed, it is well known that the lower portion of the vessel dilates in common with the branches opening into it; that various small veins become large,—for example, the superficial abdominal or azygos major,*—and so carry to the heart the blood which ought to have reached the right auricle by the usual channel. Such cases have been long on record. One, described by Halford, is preserved at the College of Surgeons, and shows the iliac vein slightly dilated below an obstructing coagulum, a varicose (dilated) set of veins about the groins having carried on the circulation for several years before death.* This kind of dilatation ceases when the veins can conveniently carry the extra quantity of blood, and the change is permanent or temporary as the obstruction remains or is removed, for in the latter case the veins usually regain their ordinary size.

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* Museum, Guy's Hospital, 1521$^{\underline{32}}$.

The only anatomical change which attends this increase of a vein is the addition of transverse fibres to its middle coat; its length is unaltered, and its walls remain smooth and uniform, save where pouches behind the valves account for slight irregularities; but, as noticed by Baillie and Watson,† "the vessels are often bent and wisted when the current forces its way backward against the opposing but ineffectual barrier of the valves."

If the obstruction to the circulation is in the heart, or in the ungs, that is to say, in one of the central organs through which all blood must pass, no round-about channels can rearrange the circulation. The veins still dilate, but the change is passive, and accommodates them to the blood which accumulates within their canals, ecause its onward passage is impeded. Thus it is, with obstruction rom disease of one of the valves of the heart, that the entire venous ystem dilates, so that veins which can be seen, such as the external ugular, are turgid and distended. Maybe, with this dilatation, here is proportionate strengthening of the vein-wall; but it more commonly happens that the yielding is simply passive, increasing ntil relieved by rupture of the wall (hæmorrhage), or by exudation f serum (anasarca).

Atrophy of veins, in common with atrophy of other structures, naturally follows disuse of a part. After amputation above the nee, the femoral vein lessens to one-third of its previous size; ter removal of a testicle, the corresponding spermatic veins shrink d waste. In a case in which the right kidney had been transrmed into a large cyst from the impaction of a calculus in its eter, the canal of the renal vein would not admit an ordinary-sized probe. It is needless to multiply examples, for atrophy is simply what would be expected when a part ceases to be of use, as in the case of the umbilical vein shortly after birth.

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* Museum, 1732. See cases by Morgagni, Portal, Petit, Cline, and hers; also Reynaud, in the *Journal Hebdomadaire*, tom. ii., Paris, 1829.

† Museum, Middlesex Hospital, series vi. 32c. *Trans. of a Society for Improvement of Med. and Chir. Knowledge*, vol. i. p. 127.

Degeneration of the coats of a vein never associates with atrophy of the vessel; indeed, its rarity under any circumstances offers a marked contrast to its frequent occurrence in arteries. In the museum of St. George's Hospital,[*] a vein from the broad ligament of the uterus contains a round white mass within its tunics, the vein being pervious; in another case,[†] a calcareous deposit involves the internal saphena; and Baillie mentions a case where a similar deposit was found in the coats of the vena cava inferior, near its division into the common iliacs. Béclard observed calcareous degeneration in the femoral vein, and Macartney and Andral in the internal saphena. It has also been met with in the hepatic veins;[‡] but its occurrence may be considered accidental wherever situated. Indeed it is doubtful if these calcareous plates should be regarded as a degeneration of the vein-wall; it is more probable that they depend upon an after change in some local deposit of fibrine.

Varicose Veins.

Varicose veins. *Varix.*[‖] *Phlebectasis.* When a vein becomes dilated without any good object or purpose, it is said to be varicose. In the active or passive dilatations already described, which adapt these vessels to certain states of the circulation, the purpose is as evident as is the gain which results. Not so with varices. No good comes from them. They are useless and hurtful.

Many of the early medical writers were familiar with much that is at present known respecting varix. It is still the "dilatation of a vein" described by Paulus Ægineta;[§] and our treatment of th dilated vessel continues practically unchanged. Some veins, so fa as is known, are unaffected by varices, while among those whic have been reckoned as varicose a considerable number ought rathe to be referred to that hypertrophy with dilatation which has bee already described. Thus the tumours formed of tortuous and dilated subcutaneous veins (fancifully likened by Severinus* to the head of Medusa), which occasionally occupy the hypogastric region, simply compensate for the obstruction of some large vessel, such as the vena cava inferior, unless indeed they are due to that congenital communication in rare cases maintained between the portal system and subcutaneous vessels of the abdomen by means of a patent umbilical vein, and of which a few instances are on record.†

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[*] Series xii. subseries 6. e. 1, 2.

[†] Museum, St. Thomas's Hospital, Y, 170.

[‡] Museum, College of Surgeons, 1438.

[‖] *Varius*, unequal. Græcis κιρσὸς aut ἰξία Hippocrati dicitur.

[§] "Varix venæ dilatatio est, aliquando in temporibus. aliquando in u ventris parte, sub umbilico, nonnunquam etiam circa testiculos, sed maxim in cruribus." *Opus de Re Medicâ*, Lat. don. p. 50, Paris, 1532.

True *varices* are habitually met with in the submucous veins of the bladder and rectum (hæmorrhoids),‡ in the spermatic veins (varicocele, cirsocele),§ and in the veins of the lower extremities. They are also, though rarely, met with in the veins about the face; more especially those of the lips and eyelids. In one specimen they may be seen involving the internal jugular;‖ in another, the veins of the stomach;¶ and they are said to affect the pharynx, œsophagus, and small intestine, but of these the records are unsatisfactory. One case of varix at the bend of the elbow is recorded by Petit; and a boy is stated by Warren to have suffered from varix which formed between the shoulder and elbow after violent muscular exertion;** but phlebectasis of the upper extremities is a rare and accidental occurrence.

Varices of the *lower extremities*, though much had been written respecting them, received but little attention from anatomists. This neglect occasioned and maintained the error of Boyer, adopted by most of those who wrote upon the subject, that varices are an unnatural permanent dilatation of the *subcutaneous* veins, from which the *deep* veins are at first exempt, and that the latter, constantly sustained by the muscles, receive from these contractile organs a support by which they escape dilatation, whilst the subcutaneous, less well supported, can expand indefinitely.†† The disease, thus limited in its origin to one set of vessels, was said to be caused by a retrograde movement of the blood, or by a mechanical obstacle to the return of the blood to the heart, or by a communication between the arteries and veins, small vessels passing directly from the one to the other. The last suggestion, however attractive in theory, failed from the absence of anatomical proof, for the presence of the anastomosing vessels has never been shown by dissection.*

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* M. A. Severinus, *De recond. Abs. Naturâ*, cap. ix. § 13.

† Cruveilhier, *Anat. Path.* liv. xvi. pl. 6.

‡ See Diseases of the Rectum.

§ See Diseases of the Male Organs of Generation.

‖ Museum, St. Thomas's Hospital, y, 155.

¶ Museum, College of Surgeons, 1158.

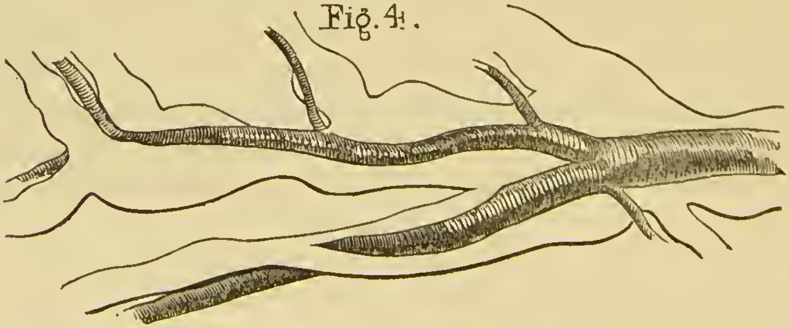
** *Traité des Maladies Chir.* tom. ii. p. 49; *Surgical Observ. on Tumours*, p. 432.

†† Boyer, *Traité des Maladies Chir.* tom. ii. p. 451; Sir Everard Home, *Practical Observations.*

The error of Boyer's doctrine rested upon insufficient anatomical research; for in fact varices do not invariably commence in the trunk of the saphena, or in that of any superficial vein. The seat of varices, as shown by Verneuil,† is as often in the deep veins, and they thence extend to the subcutaneous vessels by the numerous anastomoses existing between the two sets; and far from being rare, the deep varices are of very frequent occurrence.

There are various veins in the thickness of a limb: some deeply seated in company with the great arteries, the popliteal, posterior tibial, and the like; some which lie in the subcutaneous tissue; and lastly, intramuscular veins, which convey blood from the muscles to the deep or superficial vessels, and form anastomoses between them. These intramuscular veins carry large quantities of blood, and their capacity is great in proportion. I find that the six principal veins which pass in the adult male from the soleus muscle to the peroneal and posterior tibial vessels, have a united diameter of not less than an inch. Where these vessels open into the deep veins (more especially the peroneal and posterior tibial), the latter are often greatly dilated, as may be seen by the accompanying diagram, which indicates their condition in a case of varix which I examined in a body brought to St. Bartholomew's for dissection. Broca, quoted by Verneuil, found deep varices equally with the subcutaneous; Denucé observed that they were less rare than had been supposed, and existed even when the subcutaneous veins were unaffected;

Fig. 41.



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* Pigeaux, *Traité pratique des Maladies des Vaisseaux*, Paris, 1843.

† *Gazette Médicale*, 1855.

Deville and Fouché, their attention being called to the subject, confirm his statements; and Dumay communicates a case in which, whilst tying the peroneal artery, it was found to be surrounded by large varicose veins with extremely thin walls.

According to Verneuil, the intramuscular veins also become varicose, and specimens are preserved in the Musée Dupuytren* to show they are sometimes affected without change in the subcutaneous. In my dissections I have failed to meet with this intramuscular varix; but from the examination of bodies brought for dissection, in which varices are occasionally discovered, and in which the vessels have been carefully traced, I can confirm the statement of Briquet, that at the spot where varices are most common, large trunks communicate through the muscles with the deep veins; and I find the latter as commonly diseased as the superficial vessels, the disease being most advanced where the intramuscular veins empty their blood into either set.

Certain conditions of system favour the formation of varices, congenital predisposition amongst others; a disposition thought by some to be hereditary. Very little is known about it. Persons with an indolent temperament, or persons reduced in health, suffer from a relaxed and debilitated condition of the vein-walls, which lose their tone and their elasticity, and then offer little resistance to the pressure of the blood. In some cases, the heart's action is reduced in frequency (I have seen young adults in whom it beat but forty times in the minute) and in force, so that it slowly and with difficulty relieves itself of the venous blood. Such people, and others to a less extent, are more likely to suffer from varix if their occupation is one which habitually involves much standing or walking, in fact, any long-continued muscular exertion; and so cooks and grenadiers have been selected by Brodie and by Home as especially prone to the formation of varicose veins. They are developed chiefly during the active middle period of life; but their appearance may be postponed until old age, or may be referred to early life, since they not unfrequently occur in children under ten years of age.

Obstruction to the circulation is a passive aid to their formation. Hence they coincide with certain diseases of the heart, of the lungs, with cirrhotic liver, and are common when the portal system is overcharged with blood, as with those who *live well*, though such suffer more especially from varices of the rectum (hæmorrhoids).

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* Specimens 254, 259.

Constipation involving the accumulation of fæces in the intestine and pressure upon the iliac veins, the obstruction of veins with clots, the pressure of tumours, and such artificial pressure as that of an ill-adapted hernia truss or tight garters, may be enumerated as examples of conditions which retard the circulation, distend the veins, and prepare them to become varicose.

Such conditions have more influence upon the veins of the leg, because the pressure of the column of blood which these vessels have to resist is increased by gravitation. Although the column of venous blood, ascending against its own weight, is supported by the column of arterial blood, yet the pressure of the fluid upon the walls of the veins increases by gravitation, inch by inch, towards the most dependent portions of the body. To illustrate this fact, the small intestine, freed from its mesentery, may be held so that its upper and lower outlets are upon the same level, the intermediate curve being pendent. If its canal is filled with water, it is easy to compare the lax condition of its walls above with their tension, almost to bursting, at the curve below. In the veins this tension is relieved by valves, and some dilatation is permitted, as occasion requires, by their thin and yielding walls; but when the occasion passes by, the elastic vessels soon recover their natural capacity, and then the slightest force acting upon the blood-column tends to quicken its movement through the venous system. If there exist a tendency to dilatation by obstruction, such force, instead of moving the blood-column, is expended upon the vein-walls;* and if the force is represented by a certain quantity of blood forced into a vein, then there is added an increased tendency to dilatation by excess of contents.

In persons with relaxed and debilitated veins the varicose condition would seem to be determined by the habitual *over exercise of muscles*, especially those of the calf of the leg, which force the blood violently into vessels inclined to yield to the distension, and already overfilled by reason of a retarded or obstructed circulation. The dilatation which ensues is usually of slow progress; indeed, for a time the veins are often increased in thickness and strength to resist this distension; but Paré records cases, and his observations are confirmed, in which large varices have suddenly appeared after violent muscular exertion,† such as running, dancing, or carrying heavy weights. Wherever, so far as superficial varices are concerned, the intramuscular veins pass into the subcutaneous, there the varix is first noticed; there the force, that is the blood-stream impelled from the muscles, tends to act on the vein-wall and to dilate the vessel; for the valves obstruct below, and the column of obstructed slow-moving blood resists above.

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* See experiments by Williams, *Principles of Medicine*, 2d ed. p. 188.

† Warren, op. cit. See also Malgaigne, *Œuvres compl.* t. ii. p. 268.

The *anatómical changes* in varicose veins have been described by Andral; and his distinctions, though too minute, have been generally adopted.* In brief, it is sufficient to notice, that the coats of the dilated vessels may become thickened, or may become thin; that they may be lengthened, so that the veins are rendered tortuous; that the dilatation may be unequal, the vein being marked with pouches, which form at the sinus behind each valve, or result from the greater yielding of the vessel where the blood is forced into it from an intramuscular branch; that varix of the femoral vein, which occasionally requires to be distinguished from a femoral hernia,† is thus formed by yielding of the vessel at its junction with the internal circumflex, saphena, and profunda veins.

As the vein-canal dilates, the valves, unless previously ruptured by violent and sudden muscular action, are unequal to close the passage; and, being useless, they presently waste and are reduced to mere fibrous bands, or disappear altogether.‡ The valves are not destroyed by the backward pressure of the column of blood obstructed in its passage to the heart; for they are adapted, as is well known, to resist this pressure, and they become, when needful, thick and strong, to fit them for doing so. But the force represented by the stream of blood advancing from below, and from the intramuscular veins, presses upon their rear, and, as they are unable to resist a force acting in this direction, flattens their cusps against the vein-wall; and there, when the vein, from the combined action of several causes, has become so large that the valve-cusps are unable to meet and close its canal, they shrink and atrophy. It follows that, in varices, those valves only are thus destroyed which lie between the lowest varix and the heart; and, when they are destroyed, that the pressure of the blood-column, which they helped to resist, weighs more heavily upon the dependent and dilated vessels.

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* Varices: species 1. Simple dilatation, affecting the whole length of a vein, or existing only at intervals. 2. Simple dilatation, with thinning of the parietes. 3. Uniform dilatation, with thickening of the parietes. 4. Dilatation at intervals, with thickening at the dilated points; in this, and in the third species, the vessel being lengthened as well as dilated. 5. Dilatation, with the formation of septa, which divide the interior of the varix into many compartments, in which the blood coagulates. 6. The addition to the last of many small apertures in the walls, allowing the escape of blood, as in erectile tumours. *Pathological Anatomy*, Eng. trans. vol. ii. p. 4 et seq., Dublin, 1831.

† See HERNIA.

‡ Museums, Coll. of Surgeons, 1736, and Bartholomew's Hospital, series xiii. 79.

The tissues which surround the diseased veins become gradually absorbed in consequence of the continued pressure of the varix, and thus, as noticed by Hodgson,* bones even become indented. So thin, indeed, may the coverings of a varix become, that, with sudden exertion, or from a blow, they rupture, and hæmorrhage ensues. In cases of long standing, however, it is usual to find the neighbouring structures thickened and hard from simple œdema, or from inflammatory exudation, which, by involving the neighbouring lymphatics, causes many of them to be permanently obstructed; so that, what with their obstruction and the obstructed vein-circulation, the whole leg becomes œdematous, and in time accumulates a great superfluity of fibro-cellular tissue, a condition which in severe cases is recognised as the Arabian elephantiasis.†

Varices of the lower extremity do not affect especially the left limb. The curious error which long prevailed, and gave precedence to the left leg, has been completely exposed. Statistics obtained by Verneuil, from cases observed at the Hôtel Dieu, show that one limb is diseased just as often as the other. In fact the cases are rare, if they ever occur, in which the disorder does not affect both limbs simultaneously, although the greater progress in the superficial veins, which is observed in one limb, commonly causes the condition of its fellow to be passed by unnoticed.

Symptoms. Though varices may exist for a long time, and cause little, if any, inconvenience, yet it is more usual for those who suffer from them to complain, some time before the external manifestation of the disease, of aching pain, deep seated in the limbs, with sense of weight, fulness, and fatigue, in some cases complicated with a certain numbness and even loss of power in the extremities. In a more advanced stage of the disease the ankles swell after a hard day's work, and the feet are constantly cold. These symptoms indicate an embarrassed state of the circulation, to which is gradually added dilatation of the deep-seated veins, and more especially of the posterior tibial.

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* Op. cit. p. 561.

† For erectile tumours, and their relations to varices, see Nævi.

After a time, at one or more points in the leg a small tumour is formed, soft, of a bluish colour, from the dark blood showing through the integument; it disappears on pressure, but returns when the pressure is removed, or when the patient stands up, and is caused by a vein which is dilating where joined by an intramuscular branch. Around this tumour a series of minute vessels are clustered of a dark, bluish colour—the small superficial veins through which the passage of the blood is retarded to a greater degree than elsewhere, because they open directly into that part of the vessel which is dilating. By degrees the dilatation extends and involves an increasing length of vein, and then forms irregular, knotty, convoluted tumours, soft and diminished in size by the horizontal posture, giving a bluish tint to the skin, which is stretched and thin, and surrounded by smaller veins, also somewhat varicose. These tumours are grouped around the points at which the dilatation first commenced, for the most part in the middle of the leg along the track of the external and internal saphena veins, but the clusters of tortuous vessels often extend along the entire length of the leg and thigh. To the symptoms already enumerated there is often added an unpleasant itching; and when nerve-fibrils are by chance involved, a sharp tingling pain.

Occasionally, when the varices gradually thin the skin which covers them, and burst through it, hæmorrhage ensues, which may cause syncope and even death if not promptly arrested; for the valves being destroyed between the varix and the heart, the escape of blood is directly from the proximal portion of the vessel, and may be very considerable. In treating such a bleeding, the patient should be promptly laid on the ground, and the leg should be raised, when the hæmorrhage will probably cease. If it continue, the pressure of a pad of lint applied to the bleeding vessel, and secured by a few turns of a bandage, will effectually arrest it.

In inflammation of the tissues around the veins we have the prelude to irritable conditions of the skin and eczema, to obstruction of the absorbents, and to ulceration;* and when the vein-walls from the same cause become surrounded with lymph, the condition is reached in which, as previously described, the vessels become filled with clots and obstructed. The knotty tumours are then hard and cannot be emptied by pressure, and this consolidation is permanent, for varicose veins once obstructed with clots never have their canals reopened. In this way the natural cure of a varicose cluster is often effected, with much temporary relief to the patient: as, however, the predisposition continues, and the exciting cause remains, other adjacent veins soon become involved and perpetuate the disease.*

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* For varicose ulcers, see vol. i. p. 214.

Treatment. Varices of long standing are inveterate; for although much may be done for their relief, they cannot be cured; and hence it is fortunate, although they occasion the patient much hurt and inconvenience, that they are not serious in their consequences. In their earlier stages they are more manageable; and it is much to be regretted that early symptoms are mostly unheeded, for whilst the disease is limited to the deep veins, or at most has involved but slightly the superficial vessels, it admits very readily of permanent benefit.

The management of the general health is an important item in the treatment of varices in every stage. The feeble and often ill-nourished patients who suffer from this disease, must be invigorated by tonics and a generous diet. The plethoric patient, with an embarrassed portal circulation, will gain much from often-repeated but small doses of purgative medicine, and by the use of cold saline baths. In each case some special symptoms will probably demand attention, and must be met by appropriate remedies; but in the large class of cases in which there exists a constitutional or acquired laxity of the veins, no remedy equals the tincture of the sesquichloride of iron, given in drachm doses three times daily, with an aperient pill every other night to obviate the occurrence of constipation. Under its influence, combined with proper local appliances, the laxity of the veins disappears, and the varices, if recent, are disposed of.

Provided always that the disease is not of long standing, and that local causes of obstruction, such as tight garters, are done away with, it is advisable, with this general treatment, that the legs should be rested in the horizontal position for at least a month or six weeks. Walking should be prohibited, and only carriage exercise allowed. The limbs, thus rested, should be bandaged from the toes to above the knee, the pressure being firm and equal, and the bandage (Domett) should be renewed daily. At the time of each renewal the limb should be well rubbed with the hand for about a quarter of an hour; by this treatment the circulation through the subcutaneous veins is rendered brisk, and the tonicity of the walls by degrees reëstablished. What with the inaction of the muscles, the improved tone of the superficial vessels, and the amendment of the general health, a good result may be anticipated.

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* See cases by Hodgson, op. cit. p. 561.

But patients seldom have the inclination or the opportunity for submitting to such rigid treatment for the cure of a disease which causes comparatively little inconvenience; and when this is the case simple compression of the distended veins will often give great relief, and even prevent the disease from growing worse. Sufficient support may be obtained by merely bandaging the limb, greater pressure being made over the larger of the varicose clusters than elsewhere by means of a pad of lint placed upon each of them before the bandage is applied.* Elastic spiral bandages, or the elastic web stockings, are recommended as conveniently supplying the necessary support. They should be removed at night when the patient goes to bed, and replaced when he gets up in the morning. If any one of them causes irritation of the skin, it must be changed for some other; and it will often be found useful to protect the integument by means of flannel bandage or cotton wool before these appliances are put on. The most difficult to manage are the old varices surrounded by a quantity of indurated tissue, which protects them from ordinary pressure; the difficulty may generally be overcome by the exercise of a little ingenuity in applying the supports. Travers cured a varicose cyst of the saphena by the pressure of slips of plaster. The varix should be emptied of its blood, and the strips, of a convenient length and breadth, should be then applied, crossing one another at right angles. A firm and even pressure may also be obtained by applying a wet bandage. A number of pieces of muslin, linen, or calico are prepared, each about two inches wide and twelve inches long, and saturated with water. Two of these strips are first placed beneath the foot, and their ends crossed over the instep towards the ankle. Other strips are then bound round the leg, their ends crossing in front, so arranged that the one above half-covers the one below, until the limb has been bandaged to a sufficient height. An ordinary roller is then placed over all, and each day the application is renewed.

These measures are, however, simply palliative; and in the desire to effect the cure of so common and often troublesome a disease, many devices have, from time to time, been employed. With the exception of Herapath's suggestion for dividing the fascia lata at the saphenous opening to relieve a supposed pressure upon the femoral vein, they all aim at procuring obliteration of the varix, or of the chief vein connected with it. But from all these measures it is quite certain that only a temporary benefit is obtained; for after one mass of varices has been removed, the anastomosing veins around soon acquire a varicose condition, and the disease is perpetuated. In deciding upon performing any one of the many operations open to choose from, it must be the relief, not the cure, of the varix which is anticipated; and no doubt there are cases, yet not so many as some would have us to believe, in which the pain of the varix, the impossibility of healing a large ulcer, the unfitting of a patient for his every-day work, justify the operation for the sake of the temporary benefit.

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* Local compression was first recommended by Delpech and Sanson. See Delpech, *Maladies Chir.* tom. iii.

It has been objected to these operations, that they have sometimes imperilled the patient's life, and at one time they were brought into disrepute by the occurrence of several deaths from diffused inflammation extending along the course of the vein which had been operated upon; but the objection should be made not to the operation, but to the performance of it upon patients in a bad state of health, who, to avail oneself of the quaint language of Dionis, are opprest with humours always ready to cast themselves upon any one locality.* If the cases are selected with care, the judgment which decides in favour of an operation will never be reproached by the occurrence of serious hurt to the patient; and the only troublesome consequence will be a languid condition of the wounds, which, from the indolent circulation through the limb, are, as stated by Skey, often very difficult to heal.

The operations recommended for the local relief of varices are modifications of one another. Their practice dates from the earliest record of Surgery, and some curious peculiarities of treatment may be referred to as showing the uncertain reasoning which regulated it. Thus, Celsus drew a distinction between straight and convoluted varices; for the first he recommends† that they should be exposed by cutting through the skin, and then destroyed by the actual cautery; whilst the latter he at once cut out with the knife. Ambrose Paré and Petit‡ punctured them, squeezed out their contents, and then applied a compress; but when the blood stagnated in an isolated tumour, they cut down upon and removed it. But, says Paré, old varices should be left alone, lest, being removed, the patient should be suffocated. Boyer followed Paré, but tied the vein above and below before opening it; and Home, after dividing the skin, passed a thread under the vein, and so tied the vessel leading from the varix towards the heart, under the impression that the blood, as it could no longer flow through the vessel, would stagnate, and then coagulate: and in practice Home found that varicose ulcers were thus more readily healed. From what has been here said respecting the causes of varicose veins, it is evident that no good could follow this operation; indeed, any benefit that patients obtained from its performance was probably due to the rest which it necessitated.

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* "Cocochymes et accablés d'humeurs, toujours prêtes à se jetter sur quelque partie."

† *De Re Medicâ*, lib. vii. cap. xxxi.

‡ *Traité des Maladies Chirurgicales*, tom. ii. p. 64.

Amongst other suggestions, Fricke advised that two or three threads should be passed through the vein, after the fashion of a seton; and Capaletti* employed galvano-puncture to induce clotting of the blood within the varix; whilst Gräfe† actually opened the vessels and filled their canals with lint. But all these methods were employed without any fixed idea of what was to be accomplished by their means.

Our object is now more definite, as we seek to relieve for a time this varicose condition by causing coagulation of the blood within the dilated veins, which then shrink and contract permanently. This result can be attained, 1st, by the action of caustics applied over the course of the vessel; 2d, by subcutaneous division of its walls; 3d, by compressing it between a steel pin and a twisted suture, or by some similar contrivance. The potassa fusa, or Vienna paste,‡ may be applied as recommended by Mayo, in quantity sufficient to cause sloughing of the skin over a varix, or the venous trunk connected with it. The tissues beneath the slough inflame, the vessel is filled with coagula, and so becomes obliterated. The slough should not exceed a quarter of an inch in its diameter, and the surrounding skin should be protected from the action of the caustic by a ring of plaster encircling the portion to be destroyed. Brodie recommends that sufficient caustic shall be employed to insure sloughing of the vein, as a more certain mode of securing its destruction, the vessel becoming closed and contracted above and below the slough. According to circumstances, two or more of these sloughs will be required, and in making them they must be carefully kept some distance asunder. Whether the varix is thus itself destroyed, or the venous track which passes from it, the blood which formerly passed through these vessels is driven into other channels, which gradually dilate into a fresh crop of varices.

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* See *Archives Générales*, 1848, p. 228.

† C. Bell's *Surgery*, German trans., preface.

‡ Composed of five parts of quick-lime and four of caustic potash, made into a paste with spirits of wine immediately before its application. Nitric acid may be substituted when it is only required to excite inflammation about the vein.

Subcutaneous division of varicose veins is easily performed by means of a narrow pointed bistoury, first employed by Brodie,* which is introduced between the skin and the vein, and is made to divide the latter as it is withdrawn. A compress of lint should be at once applied to restrain hæmorrhage. This operation has the advantage of leaving a wound which heals readily, often by the first intention; but in some cases suppuration has followed, and in some it has failed to obliterate the vessel; so that, says Brodie, "it really appears it is not worth patients' while to submit to it. I have always observed, that if I cured one cluster, two smaller ones appeared, one on each side; and that ultimately I left the patient no better than I found him." If this operation is performed to facilitate the healing of a varicose ulcer, the vessel should be divided below, so as to interrupt the blood as it streams in from anastomosing vessels and causes the distension of the veins about the ulcer. After this or any similar operation, the patient must be kept quiet in bed for at least four or five days, and longer if necessary.

Velpeau, following Davat, employed a metal pin, which he passed under (never through†) the vein, and on which he applied a twisted suture. The pin was allowed to remain in until sufficient inflammation had been excited to promote obliteration of the vein; but when the irritation which followed was but slight, the pin was left to come away by ulceration of the structures which covered it. Some of these pins he applied to the varicose clusters, and some to the veins communicating with them; and as no very bad results followed his operation, it was pretty generally tested. But, like others, it affords only temporary relief; and besides is open to the objection that the sores which result are often difficult to heal, although this is an objection more especially to the treatment by caustics. To prevent sloughing of the integument, it is recommended by some Surgeons to protect it from the twisted thread by means of a piece of wax bougie. Various other devices for conveniently securing the obliteration, have from time to time been suggested.[*] A good and expeditious plan is that recommended by H. Lee, by whom it is thus described: "A needle is introduced beneath the vein or veins to be obliterated, and an 8-ligature is passed over its extremities. The vein or cluster of veins is thus included between the needle, which is below it, and the ligature, which is over the skin. The ligature is then tied so as to produce a slight degree of pressure on the vein, and by this means its cavity is temporarily closed by acupressure. Another needle is then passed under the vein at about an inch distance, and the vessel is there closed in like manner. The vein or cluster of veins thus included between the two needles is entirely separated from the rest of the circulating system, and may then be divided or otherwise obliterated without risk. Subcutaneous section of the vein is generally all that is necessary, and is preferable to any other mode of operating, as it effectually obliterates the vessels without leaving any open wound. At the expiration of about four days, when union is established in the divided parts, the needles are removed, having served their temporary purpose."

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* *Lectures on Pathology and Surgery*, p. 185.

† Transfixing the vein and passing a thread through it, as proposed by Fricke, was found to occasion such great irritation that its use was presently abandoned.

Except in cases which have been referred to, these operations are not to be recommended; and the patient, if wise, will be content with the palliative measures of a more simple character.

I have several times referred to tumours as causing obstruction to the circulation of the blood through veins. Little inconvenience follows, in consequence of the ready formation of a collateral circulation. Some tumours compress veins against a resisting substance, as bone; some by their growth completely surround them; whilst others extend into their canals, as was first pointed out by Langstaff in a case of medullary cancer. In many instances they cause obliteration of the vessel by interruption of its canal and by absorption of its coats, or they induce the formation of clots, by which it becomes permanently obstructed. Now and then a tumour appears to have its origin in and to be confined to a vein, as happened in the splenic, as recorded by Hodgson, and in a case, related by Andral,[†] where the growth consisted of adipose tissue in the wall of a portal vein.[‡]

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[*] Metal pins for compressing veins are described in the *Medical Times and Gazette*, vol. ii. 1861, p. 377.

[†] Op. cit. vol. ii. p. 423.

[‡] The following specimens give a good general idea of these vein obli-

A few words will dispose of the subject of worms and other parasites which were formerly supposed to infest veins. The more exact and minute examinations of the present day have refused in this matter to confirm the statements of the past. Parasitic animals, except in the doubtful cases of migration of the embryo of tænia, are no longer found in these vessels.*

G. W. CALLENDER.

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terations. Middlesex, series vi. 32, 35: vena cava obliterated by pressure from an aneurism. St. Thomas's, Y, 171: vein filled with encephaloid deposit. Guy's, $1521^{\underline{65}}$: vena cava obliterated by the side of a dried-up hepatic abscess; and $1521^{\underline{90}}$, by pressure from enlarged glands. Guy's, $1522^{\underline{7}\ \underline{15}\ \underline{25}}$: growths of cancer into superior venæ cavæ. St. Bartholomew's, 13. 29: fleshy growth between vena cava and kidney, obliterating the former. Aneurisms and abscesses, though they sometimes burst into adjacent veins, may also cause obliteration: St. Bartholomew's, 13. 84; St. Thomas's, Y, 154; St. George's, xii. subs. 5. 1.

* Andral, Duval, Freubler, Fabricius, and Rudolphi, Virchow, and Leuchart, may be referred to. I find mentioned by one or other of these, echinococcus altercipariens and distoma hepaticum in the hepatic veins; acephalocysts in the pulmonary veins; strongylus and filaria in the veins of a horse; and entozoa belonging to the class nematoidea of Rudolphi in the right ventricle of a porpoise. Hæmatozoa, as they are termed, are said to be found in the veins of birds, reptiles, and fish, having perforated the vessels, as it is assumed, in their wanderings, and being then washed along the blood-stream until they stick in the capillaries. Leuchart, quoted by Küchenmeister (Syd. trans. vol. i. p. 50), professes to have met on four occasions with the embryo of tænia migrating through the main branches of the vena porta. See also Siebold, Syd. trans. p. 29.

DISEASES OF ARTERIES.

Atheroma.

THIS disease is of much importance in practical Surgery, from the frequency with which its effects are observed in weakening, enlarging, and occluding arteries.

The earliest stage of atheroma is that in which a thin, soft, and clear membrane lines a part or the whole of an arterial tube. It appears at first scarcely distinguishable from the natural inner coat of the vessel; its free surface has the shining smoothness of that membrane, and as it acquires firmness and a closer union with the original internal coat, it furnishes in fact a new lining to the artery. This structure is added to the artery without the slightest appearance of disease in the original textures of the vessel. Its coats are neither infiltered nor inflamed. There being no manifest cause in the artery itself for the formation of the new membrane, it may be looked upon as probably deposited upon the interior of the vessel from the blood.

This opinion as to its source is confirmed by the fact that the inner coats of an artery are entirely devoid of nutrient blood-vessels, from which it could be secreted, and by observing the further progress of the disease. On the inner surface of the new deposit a layer similar to the first forms, and, like it, becomes consolidated, firmly adherent, and in its turn the foundation of additional depositions. When many of these strata have thus accumulated within the vessel, the whole mass is no longer transparent, but becomes opaque, dull, and concentrated, by loss of moisture or some organic change, into a material similar to hardened albumen, and eventually to ligament. The layer last deposited may still be often detected, thin, smooth, soft, translucent, overlapping the edge of the deeper mass, and possessing, both in appearance and on microscopic examination, the characters of a lining membrane.

Until the deposit has become consolidated, the coats of the artery remain unchanged; but as by their adhesion over its indurated mass their function is destroyed, they waste, and lose their firmness, elasticity, and natural colour.

One of two changes may occur in such an indurated lining plate of an artery. It may soften in its interior, or be converted into a layer of cretaceous matter. In either case, the attenuated coats of the artery around it will probably be unnaturally vascular; inflammation, though not occasioning the disease, being almost always produced by it.

Both the softening and the change into bone take place in the deeper parts of the deposit. In the former process it degenerates into a thick pulpy mass of cholesterine, oil-globules, and albuminous and cretaceous molecules. The inner strata separate this pulp for a time from the blood; but when they give way, the whole is gradually washed out into the stream, and the base of the cavity, composed of the weakened walls of the artery, is exposed to the force of the cardiac impulse of the blood. The possible occurrence of an aneurism, particularly a dissecting aneurism, in this condition of the vessel will be evident.

Cretefaction, or ossification, likewise occurs only in a thick deposit, and in its external, oldest, deepest layers. The inner surface of a bony plate of an artery is for some time lined by the most recently laid stratum of membrâne; but at length this also ossifies, and the plate is exposed in the vessel. Externally, nothing intervenes between the plate and the middle coat, for the original lining membrane partakes in the chalky degeneration. The bony growth presents a marked difference of form in different specimens, and still more in different arteries. In the aorta, the innominata, and the common iliac arteries, it assumes that of plates of different sizes, irregular in outline, generally concave and smooth internally, rugged and convex externally; whilst in all smaller arteries it grows in the shape of rings, which so exactly answer in their position and direction to the yellow circular fibres, that they have been regarded as ossifications of that coat. In some of the larger arteries, a rough prominent mass of bone may even project into the canal, a growth of so peculiar an aspect as to be compared by Professor Rokitansky to stalactite.

The other coats of an artery thus diseased are necessarily altered. Neither the fibrous nor the cellular coat shows any change during the early stage of the process; but as it advances, the former becomes of a dirty-yellow colour, loses compactness, and admits of being easily stript off. With its natural texture, it loses the power to resist the force of the current; it dilates, and is more or less thinned out. Spaces are thus formed between its fibres, through which the bony deposit comes into contact and adhesion with the cellular coat of the vessel. This degeneration of the fibrous tunic is of the fatty kind. The outer membrane at first becomes unnaturally vascular, swollen with infiltration, and manifestly inflamed. As the activity of this process subsides, it is converted into a callous, white membrane, closely adherent to the deposit and to the remnant of the middle coat.

The extent to which atheroma affects the system of blood-vessels is very various. In some instances, every artery sufficiently large to be named by anatomists is thus diseased ; in others, certain vessels or parts of vessels are unaffected by it. Extensive atheroma of the aorta is almost invariably attended by disease of the other arteries ; or, to state the same fact in the form in which it is usually presented to the Surgeon, if the vessels of the limbs are found diseased, it may be presumed that those within the trunk are in a similar condition. It is necessary to note the instances in which the disease is limited.

The aorta may be diseased throughout, yet the coronary arteries may be healthy ; and it is interesting to contrast the highly nourished state of the heart in such a case with its condition when its nutrient arteries are diseased. The aortic valves, the commencement or the whole of the arch, may be atheromatous, and no other vessel be affected. Isolated patches of the disease may occur between long tracts of healthy artery, and it is of the greatest importance in Surgery to know this fact in relation to the popliteal and axillary arteries, of which short portions may be even ossified, while the femoral and subclavian, so far as concerns the possibility of their being successfully tied, are healthy. When at all advanced, the disease is found to be symmetrical, the arteries of opposite limbs being equally and similarly affected. This fact is well illustrated in the not unfrequent occurrence of parallel, almost contemporaneous, popliteal aneurisms in the same person. Some vessels are earlier, if not more frequently, affected with the disease than others. There is such a preponderance in the lower extremity over the upper, both in the proneness of its vessels to the disease, and in the degree which atheroma attains in the more distant limb. Some entire arteries rarely become atheromatous. Those of the stomach, liver, and intestines, are remarkably exempt from this affection, even though it may have attained an advanced degree in the splenic and the other arteries of the body. As a general rule, atheroma is a disease of the arterial trunks and larger branches, but it is occasionally met with in very small vessels. On one occasion, when making horizontal sections in the ordinary mode of examining a brain, I found all the minute vessels ascending through the central white matter of the cerebrum converted into stiff wires of bone, the first incision of which blunted the knife. Haller once met with atheroma in the hypogastric artery, but it is the only case on record. The most marked exemption, however, is that of the venous system, including the pulmonary artery and its larger branches; and it is a very suggestive fact in reference to the causation of the whole disease. Atheroma, even in its early stage, is rarely found in the vessels which carry venous blood; and when it does occur, it is associated with a very advanced and extensive degree of the disease in the aortic system.

So marked a difference in the liability of the two systems of vessels to this disease might seem to point to their structure as its cause, and lead to the error of regarding it as an affection of the middle coat of the arteries. But that a mere difference of structure cannot account for the exemption of the venous system is evident from the facts, that the contrast between the two systems is continued into the heart itself, that the deposit is at least as abundant in the vein as in the artery in cases of arterio-venous aneurism, and that it is readily formed within the pulmonary arteries, when a preternatural communication admits arterial blood from the left to the right side of the heart. The rapidity of the arterial current has probably some connexion with the deposition, though not with the production, of the morbid material. As the fibrin of freshly drawn blood, when whipped with a birch, clings in masses and strings to each twig, so this morbid material adheres to all roughnesses and obstacles lying in the course of the blood: to an uneven or a perforated aortic valve, to the sharp margin which divides the aortic into the two iliac streams, to the mouths of branch arteries, to a cracked or prominent bony plate, to foreign bodies. Considering the facts already stated, and the great accumulations of this substance which both line the left auricle and encumber the valves of the left side of the heart, we may conclude that the atheromatous deposit is a product of morbid blood freshly charged with oxygen; and that unless the material exist in the blood in very great abundance, the power of furnishing a deposit is expended as the blood passes through the capillaries.

With regard to the source of the morbid material, it is to be observed, that the disease prevails chiefly in persons who are in the decline of life, and that it is associated with a defective nutrition of the normal structures of the body, and with an accumulation of fat. An attempt has been made to connect it with the inordinate use of alcohol; and there can be no question of its frequent, if not invariable, occurrence in drunkards. There must exist, however, some more hidden fault in the formation or purification of the blood, to which, rather than even to alcohol, the disease must be attributed. Young found calcareous concretions in the arteries of an infant; Wilson in a young child; and Andral in the aorta of a child of eight years of age. The latter author also met with ossific laminæ in the aorta in five or six persons of from eighteen to twenty-four years of age, and an extensive ossification of the superior mesenteric artery of a person not quite thirty.* Corfe records an instance of fatal aneurism, as arising from this disease, at the age of twenty-eight;† and in the Hunterian Museum, No. 1679, is a specimen of it in no alcohol-drinker, but in a jaguar. The gouty, the aged, the rheumatic, the persons whose tissues are imbued with fat, and those whose excretory organs fail to purify the circulating blood, are far more prone to the disease than the phthisical, the cancerous, or the young.

The microscopic examination of the white and buff-coloured deposits shows them to be chiefly composed of granules and oil-globules. Mr. Gulliver first described them as containing cholesterine, oleine, and often some margarine.‡ Chemical investigations of the bony plates, by Dr. Bostock, proved them to contain "a minute trace of albumen and gelatine, animal matter, much phosphate of lime, a little carbonate, and a trace of sulphate."§

The atheromatous change in an artery is necessarily slow in its progress, and can only when far advanced be detected in the living subject. When actually ossified, an artery which can be felt at all may be readily distinguished as thus diseased. In the radial, for instance, the rings of chalky matter can be easily recognised as the finger is moved along the vessel. But attention is often first called to the state of the arteries rather by some secondary symptom of their disease than by the atheroma itself.

1. Atheroma is at first attended with a narrowing of the calibre of the vessel, in proportion to the thickness in which it is deposited. This is most marked at the bifurcation of trunks, and at

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* Copland, *Dict. Med.* vol. i. p. 119.

† *Physiognomy of Diseases*, p. 129.

‡ *Med.-Chir. Trans.* vol. xxvi. p. 90.

§ Ibid. vol. xix. p. 87.

the mouths of small vessels passing off from large trunks. In no spot is it more commonly observed than at the origins of the intercostal and similar arteries, which branch off at right angles from the aorta, and which are sometimes not only narrowed, but at last completely closed, by the accumulated deposit. Though the larger arteries are perhaps never obliterated by this process, yet even they may be much contracted by it. The canal of so large a vessel as the common iliac has been found diminished by one-half,* and the great ascending branches of the arch of the aorta nearly obliterated. Of the latter occurrence, Dr. Yelloly recorded an instance. A man, aged fifty-six, who was supposed to be in health, but who had suddenly fainted two or three times in the two years preceding his death, fell and died while at work in his garden. The arch of the aorta was dilated and atheromatous, and the three great vessels ascending from its arch were in a considerable degree plugged up with a growth similar to the lining membrane of the artery, and without any ossific deposit.† A diminution of the size of branch-vessels from this cause may prove to be of serious importance in some cases, by hindering the establishment of a collateral circulation.

2. A later consequence of the disease is dilatation of the vessel. The power of the outer coats being insufficient to compress the deposit, and to close in upon the blood by which each cardiac systole distends them, they remain wide and fixed during the diastole, and the artery slowly expands. This enlargement is the most marked in those parts of the vessels through which the current of the blood is in any degree obstructed. All curved arteries, therefore, are disproportionately dilated. It is observed also in all parts at which an arterial trunk naturally widens in its course, and suffers in consequence a more forcible internal hydraulic pressure than the smaller tube which leads to it. The upper extremity of the common carotid is thus widened naturally, and dilated when atheromatous. In that situation, at the upper end of the innominata, and in the higher part of the femoral artery, the expanded vessel may claim attention as an aneurism.

3. The same mechanism which converts an artery into a fixed tube, incapable of contraction, but liable to dilatation, produces a similar effect upon its power of retraction. A healthy artery is in a state of longitudinal tension. It is, as it were, too short for the

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* Hunterian Museum, 1614.

† *Med.-Chir. Trans.* vol. xii. p. 576.

limb to which it belongs; and, if cut across, may shorten an inch or more.* Atheromatous and bony plates destroy this retractile power. But though incapable of shortening itself, the vessel is not incapable of being lengthened by the repeated injections of blood along it. Arteries, therefore, in which atheroma has reached an advanced degree, become not only dilated, but also tortuous. The outline of brachial arteries thus affected may be seen in the bare arm, every pulsation of the heart increasing their curvatures. The common and external iliac arteries, too, bend far from their normal position, the former arching outward and forward between the aorta and internal iliac, the latter leaving its place upon the psoas, and curving deeply into the pelvis in a new course.

4. An ossified artery does not retain that smoothness of its interior which characterised the earlier deposition within it. In a large vessel like the aorta, a bony plate may crack across, or be lifted at its edge from the wall of the vessel; and the sharp rough projection thus exposed may cause the adhesion of fibrin. Strings and masses of this substance, as it accumulates, materially lessen the calibre of the vessel, or, being broken off and carried along with the stream of blood, plug any smaller artery in which they happen to be arrested. The ossification of smaller trunks, as the femoral arteries, produces in another manner a roughness of their canal. The bony matter being thickest, or sometimes only existing, at the circular rings, the vessel is necessarily strongest at those parts, while it yields between them. The interior of such a vessel is consequently no longer smooth, but is formed of a succession of alternate transverse ridges and bays; the former answering to the rings of bone, and the latter to the expanded spaces between them. Such an artery resembles the interior of a piece of jejunum, into the canal of which folds of the valvulæ conniventes project; and the effect of the arrangement, just as in the bowel, must be to materially retard the outer portion of the current through it, whilst, by detaining within the enlargements of the

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* An artery *may* shorten to this extent. I have observed the ends of a torn brachial artery, in a boy of thirteen, to have separated more than an inch and a half when the elbow was extended. On the other hand, a cleanly divided healthy common femoral artery, preserved, with the adjacent structures, in the Hunterian Museum (No. 1568), has neither retracted nor contracted. The wound is stated to have caused fatal hæmorrhage. It may be remarked in explanation, that the brachial artery is very loosely connected with its sheath, and is not fixed by branches; while the common femoral is a short trunk, and rather intimately adherent to its sheath.

vessel a superfluous quantity of blood, it thereby, and to that extent, impoverishes the system.

5. It has been already mentioned, that an atheromatous artery becomes dilated, and that it may yield and become aneurismal at a part from which the softened deposit on its interior has been washed away. It may be added, that the so-called ulcers of arteries, which are occasioned by the partial detachment or the cracking of calcareous deposits, "are sometimes so deep as to reach, and even to perforate, the external or cellular tunic."* But, even without such previous detachment of its inner portion, a diseased artery may be torn through by the direct force of the blood. Dr. J. Risdon Bennett has recorded a case of sudden death, in which the aorta gave way before the impulse of a hypertrophied heart. The "rupture was directly through all the coats of the artery; the edges of the aperture were somewhat ragged, and traversed a patch of atheroma."† Messrs. James and Rose have published similar cases of spontaneous rupture of the aorta, and Mr. Arnott one of rupture of a diseased aorta from violence.‡ It is obvious that these accidents are the more liable to occur, as the disease is limited in extent. The artery yields at its one weak point.

6. In relation to accidents, and surgical operations on arteries, the disease which we have been considering assumes a serious importance. No longer tense, mobile, elastic, these vessels become rigid, brittle, and fixed. A direct blow may crack or crush them; a severe wrench, or sudden unusual movement of a limb, may half break them; the violence which dislocates a bone may tear them in two, and give rise to a vast escape of blood. Mr. Syme alleges that he has known an axillary aneurism follow such accidents as the repeated sudden shock of a machine against the elbow, and a quick unguarded movement in lifting the arm to the head for the purpose of holding on the hat in a breeze.

When a ligature is tied upon an ossified artery, the sensation conveyed by crushing the bony tube betrays its condition. Sometimes the artery gives way. In the stump of a leg just amputated, I have seen an ossified tibial artery break three times under the ligature. The vessel was only secured at last by including a large quantity of the adjacent soft parts in the noose with it. In another case, the ligature was wound several times round the artery. The difficulty experienced in safely tying such a vessel, has suggested the plan of dissecting along the artery, and placing the ligature on it higher up. As it is uncertain whether such an artery would be better adapted to bear a ligature in any higher part of its course, the safer plan seems to be that of securing it in the face of the stump.

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* Hope, *Cycl. of Pract. Med.* vol. i. p. 145.

† *Med.-Chir. Trans.* vol. xxxii. p. 161.

‡ *London Med. and Phys. Journal,* vol. lviii. pp. 15, 19, and xviii.

To atheroma and ossification are doubtless due the majority of the failures of operations for aneurism. Notoriously is this the case with the old operation, in which the artery was tied near the mouth of the aneurismal sac. And many times also, when the Hunterian operation has been adopted, the result has been disastrous from the same cause. The process of repair cannot be perfected in a tied artery, when the lining membrane is tough, or osseous, or in a state of fatty degeneration, when the middle coat is wasted, and the outer callous and attenuated, and when the rigid tube is incapable of contracting between the ligature and the next branch. From such an artery the ligature separates, perhaps earlier than from a healthy one, and hæmorrhage pours freely and fatally from one or both of its unclosed extremities. A prudent Surgeon forbears from operating in such a case, or from tightening the ligature if he unexpectedly encounter a diseased vessel.

7. Gangrene may occur at different stages, and from various circumstances, in the course of atheroma; but, in itself, that disease is not capable of producing gangrene. For, so long as the vessels remain open, even though rigid, they allow a current of blood to pass. And, in fact, any obstruction which may be occasioned by the roughness, is, to some extent, compensated for by the dilatation of their canal, and the distal parts obtain their nourishment. But should any unusual and considerable demand upon the circulation be made by a local injury or inflammation, the circulation will prove insufficient; and, as trees with tangled roots sometimes perish in a night upon a sudden increase in the rapidity of the flowing of the sap, the distal parts will die. Gangrene is often extensive when an ossified arterial trunk becomes occluded; and the explanation of the fact appears obvious. The collateral channels, through which alone the blood can reach the remoter parts, are themselves indurated or ossified, and are incapable of adapting their calibre to the larger stream which presses through them. The unnourished structures necessarily die. These occlusions of arterial trunks are not such as are very slowly completed by the accumulation of new matter at their orifices or bifurcations, but such as arise from the more rapid deposition of large masses of fibrin upon

a rough part of an artery, or from the loosening and inversion of an osseous plate, or the washing of a detached cardiac vegetation down the current. The first, occurring comparatively early in the disease, can be made up for by the establishment of a collateral circulation; the others happen suddenly, in which case even healthy collateral arteries sometimes fail to preserve the life of a limb.

Occlusion of Arteries.

The few preceding pages contain the statement of the modes in which arterial canals are narrowed and obliterated by atheroma. Some other causes of obstruction to the current of blood remain to be noticed.

There are persons who, by certain postures of their limbs, are able to stop the pulsation of the arteries. Their radials and tibials cease to beat upon forcible flexion of their elbows and knees. Others can so depress the clavicle upon the subclavian artery, or raise that vessel by a forcible expiratory compression of the lungs, that all circulation ceases for the time in the arm. Arteries displaced with fragments of bone are often without pulsation unti the fracture is set. An exuberant osseous deposition around th fragments of a fractured bone may, in at least one situation, compress the adjoining blood-vessels. The veins in such a case suffe more than the artery: but both may be compressed. Such a situation is the fibrous canal in the adductor muscles of the thigh, i which the compression referred to has been observed to happen.

In like manner, that is to say by outward compression, morbi growths in the vicinity of blood-vessels enfeeble or stop the circulation. An exostosis once grew on the first rib in such a relatio to the subclavian artery as to give rise to the symptoms of a aneurism of that vessel, and lead the Surgeon who had charge o the case to tie the artery. Cancerous, rarely innocent, tumou compress and obliterate arterial trunks, which are found flattene and either pervious or occluded with coagula or adherent fibri Even gangrene may follow the occlusion of an artery from th cause. This, however, is a rare event, as time elapses before t compression becomes complete, and blood, in some small quantit continues to be driven through the flattened vessel. The oblitera tion of aneurismal vessels will be found explained at large in t essay on Aneurism.

One other cause of the occlusion of an artery remains for co sideration, that, namely, in which its canal is closed by an impact foreign body. The cases are now numerous in which arteries have been found plugged by fragments of morbid growths, which have been detached from one part of the circulating system, and transported into some other part along the stream of blood. The plug which is found occluding the distal vessel has often no organic connexion with its walls, and is detained in its place merely by having reached an artery too small to give it further passage. The accident is usually met with in the aortic system, and the most common situation from which such fragments are detached is the left side of the heart. Many morbid vegetations adhere to the mitral and aortic valves loosely or by pedicles, and may be broken off by the rush of blood into or out of the ventricle. Some, but smaller, fragments may, as Mr. Lee suggests, be washed out of atheromatous parts of the larger vessels.*

So long ago as 1837, it occurred to M. Legroux† to explain a case of sudden obstruction of the arteries of the lower extremities by the passage of the fibrinous plugs found in them from the heart. A similar explanation was given by M. Laugier to the Anatomical Society of Paris, in 1849, respecting a yet more remarkable case. A healthy young man died with a needle in the left ventricle of his heart, and with gangrene of the left leg. The needle was found fixed in the apex of the ventricle, with its point directed towards the aortic orifice, and covered with "decolorised sanguineous concretions, very coherent and irregular," which were prolonged into the aorta. The lower end of the aorta, and the iliac arteries on both sides, were filled with an adherent clot. It seemed plain that the plugging of the latter, and the consequent gangrene, had their origin in the detachment of fragments of the lymph which had first adhered to the needle.‡ Since that time the researches of Dr. Kirkes have shown a similar occurrence to take place in the cerebral arteries. Mr. Paget has demonstrated it in the pulmonary arteries; and Virchow, Simpson, and others have made us acquainted with it in other vessels.

An accident precisely similar in its nature, but occurring in another portion of the circulating system, is now known to be occasionally fatal in acute rheumatism, as well as to bring on the most fearfully sudden deaths in some puerperal women. The plugged artery in these cases is the pulmonary, or several of its branches, and the plug is either formed in the right side of the heart, or passes through it from inflamed veins. Cases of both kinds are reported in the publications of the day, and some of them have been collected together by Dr. Simpson and his editors, Drs. Priestley and Storer, in the second volume of the *Obstetric Memoirs.*

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* Lee on Gangræna Senilis, *British and Foreign Medico-Chirurg. Review*, vol. xx. p. 214.

† *Bulletin de l'Acad. Royale de Médecine*, tom. i. p. 434.

‡ Cruveilhier, *Traité d'Anatomie Pathologique Générale*, tom. ii. pp. 201, 296, 388.

The facts from which the explanation of these occlusions of arteries is chiefly drawn, have already been partly stated: 1. The artery is often healthy at the site of the obstruction. It may, indeed, be atheromatous, inasmuch as the occurrence in question prevails most in persons whose arterial system is diseased. Yet it is often healthy, as might be expected upon the hypothesis of the disease originating elsewhere. Sometimes the vessel is dilated to nearly twice its natural size, and, in the branches of the internal carotid especially, this enlargement renders the situation of the plug evident before the artery is opened. The latter appears to have been forcibly dilated by the repeated impulsion of the blood against the plug. 2. The plug is frequently not adherent to the vessel. The cases under consideration were for a long time regarded as effusions of lymph from the surface of an inflamed artery; but when the artery is healthy, and the plug free, that explanation is plainly erroneous. There are, indeed, not a few instances in which the coats of the artery are inflamed, and even suppuration has taken place in the surrounding structures; in these circumstances, the plug is found adherent. The inflammation, however, and the adhesion, are alike the result of the previous presence of the plug. 3. The impacted plug can be distinguished from the inflammatory lymph and coagulum which are formed in its immediate neighbourhood. Dr. Burrows and Rühle have given the most undeniable evidence of this fact, and have all but demonstrably traced the plug to another place of origin. Each of these observers detected a calcareous plug occluding an artery, and similar calcareous matter still attached to the wall of the heart.* 4. The cessation of the circulation in the occluded artery is too abrupt to have been likely to have arisen from the gradual accumulation of fibrin. It has probably not been discovered to be instantaneous, because the pulse has not been under examination at the moment of the occlusion. 5. The severe pain which first calls attention to the accident, and death, as it happens from such obstructions of the pulmonary artery, are both sometimes sudden.

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* *Medical Times*, 1853, p. 135; Virchow's *Archiv*, vol. v. p. 189.

It would far exceed the limits of this article to trace the results of this accident in the various parts and organs of the body in which it has been shown to occur. As there is no trunk which may not be occluded by a detached plug, the abdominal aorta itself not escaping, so there is no organ which may not have its function impaired, or its structure destroyed, by the deprivation of blood which this accident occasions. What may happen when organs with single arterial trunks, as the testicle, eye, or spleen, are thus suddenly deprived of their whole supply of blood, has yet to be observed. Some further remarks must, however, be offered upon the occurrence in the arteries of a limb.

When the principal artery is suddenly plugged in its higher part, a sensation of severe pain is commonly the immediate result of the accident. In some cases this pain extends along the course of the vessel, which, though pulseless, is extremely tender; in others the suffering is referred to some distal part of the limb, as, for instance, to the calf. Signs of a deficient circulation succeed; and they may amount to pallor, loss of temperature, numbness of the surface, or even to that 'torpor' which is observed to precede the total death of a limb in certain cases of injuries of vessels. Such torpor implies not only a loss of circulating blood, but also a cessation of all feeling and motor power in the limb. That actual mortification of the limb may ensue has been illustrated in the examples which have been already given in this section.

It is not every case of obstructed artery which terminates in gangrene. A collateral circulation may be established, and the life of the limb be saved. Very young subjects bear such an accident without any ensuing mortification. The constitutional vigour of an infant will endure without loss of life the obliteration of even the aorta itself at the termination of its arch. Mr. Savory has recorded an instance, probably congenital, in which "all the main arteries of both upper extremities and of the left side of the neck were reduced to solid cords;" yet no gangrene occurred.* But the persons whose cases are now under consideration are all such as have, or have had, disease, under the influence of which the gangrene may have more readily occurred.

The same general feebleness of the system may account for the progress and great mortality of this form of gangrene. Some persons die before any line of demarcation is formed; more sink during the process of separating the dead portion of the limb; a few survive until all its tissues are naturally severed, except the bones and some tendons. Upon the division of these by the knife and saw of the Surgeon, the stump may heal.

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* *Medico-Chirurgical Transactions,* vol. xxxix. p. 214.

Some at least of the obscurity which has hitherto invested the subject of *senile gangrene* is cleared away, if a previous obliteration of the arteries be recognised among its causes. There are commonly, indeed, preliminary symptoms of long duration: chilliness of the foot or hand, and frequent pains for many months, forebode the attack, and the gangrene at length originates and advances by a local dusky inflammation. Yet, though so unlike in these particulars to the form of gangrene produced in younger subjects by obstructed arteries, such an example as the following appears to have been thus caused.

A woman, aged sixty-six, wheezing and emphysematous in her breath, and having a pulse which indicated a disease of the heart, was under my care in the Middlesex Hospital for gangrene of both lower extremities. The death began at the toes, and slowly spread upwards in the course of a previous dusky inflammation. She suffered severely from the pain in her lower extremities, and died in about seven weeks from the commencement of the gangrene. Ten days before her death the left radial artery became plugged. It had beat as usual at one visit, and on the next day it was found pulsating only in the upper half of its course. In one lower extremity about six inches of the popliteal artery was plugged with adherent fibrin, compact clot, and softened clot. Below, the artery remained open, and passed unclosed from the living into the dead part of the limb, the line of separation being at the calf. Similar obstruction existed in the tibials of the opposite limb, in which the mortification reached to the ankles. The radial was plugged for about an inch with firm adherent clot, the upper end only of which tapered to an unadherent point. The vessel was of twice its natural size in the middle of the closed part, and was thickened by inflammation of its outer coats. There were a few deposits on the lining membrane of the heart, on its valves, and on the large vessels.

Treatment. The occlusions of arterial trunks which are caused by external compression can rarely be relieved. For innocent tumours seldom interfere with the circulation, being rather themselves grooved by an artery than compressing it; and malignant growths, when they have reached a size and a position in which they can produce such an effect, are commonly unsuitable for an operation. No special suggestion is required for the treatment of arteries implicated with broken bones, and none can be offered for their compression in certain situations by the growth of new bone about the fragments. The chief attention will necessarily be claimed by the manifest cause of the obstruction, at the same time that all efforts must be directed to preserving the life of the limb by warmth and a suitable posture.

The treatment of occluded arteries by an impacted plug may certainly be more properly, as it will be more intelligently, conducted, if the cause be recognised; perhaps even also more successfully than heretofore. To preserve the temperature of the limb, to favour the establishment of a collateral circulation, to augment by suitable nourishment the quantity of blood in the body, to relieve pain by methods which will least interfere with the appetite, and, more than all, to guard the weakened limb from irritation and injury which might overtask the little vital power it still retains,—are the indications before the occurrence of gangrene. When that event has commenced, the course advised in the essay on that subject must be adopted.* If the mortification advance slowly, as in senile gangrene, Sir B. C. Brodie recommends the application of a calamine cerate to the sloughing parts, and then swathing the entire limb for two or three days at a time in a very thick layer of cotton wool. No better plan could be adopted for preserving warmth, or for quieting the mind of the patient. Poultices make the parts warm for a time only, and must be frequently renewed, whilst cotton wool preserves the limb at an equable temperature, and needs not to be disturbed until the discharges from the part require removal.

The administration of opium is essential in these cases on account of the severity of the pain, and some patients preserve a clean tongue and a fair appetite whilst taking it. Others, however, cannot continue to take it by the mouth, who can yet procure refreshing sleep and other benefits by the subcutaneous injection of a little morphia. This mode of administering morphia has now been extensively used in the Middlesex Hospital, not only in the cancer wards, but for many diseases in which the strongest effect of the drug is required with the least possible quantity in the system. I have tried likewise the injection of a watery solution of opium, but it occasioned an abscess at the puncture. The morphia may be injected very many times in the same part without any unpleasant effect.

The question of diet and stimulants in cases of gangrene, especially senile gangrene, has been warmly discussed. The advocates of an animal diet assert that any treatment which deteriorates or diminishes the blood in the system, and therefore in the limb, is promptly followed by an extension of the mortification, and that the patient is strongest, and consequently the life remaining in the limb is best maintained, with such nourishment, if only its quality and amount be rightly adapted to the digestive powers of the patient, and those powers be kept in proper order. With Sir Benjamin Brodie,* they advocate the administration of stimulants in moderate quantity; that is to say, "any quantity of wine that does not occasion heat of skin, nor raise the pulse, nor make the mouth clammy, nor render the patient nervous or irritable, may be given with advantage; but whatever does more than this does mischief." On the contrary, the advocates of a very sparing farinaceous and vegetable diet assert that it checks the gangrene, whilst an animal diet and stimulants cause it to extend.. The discrepancy between the two opinions, which are both entertained by practical men, is probably to be explained by Sir B. Brodie's caution not being observed. If these patients take opium and animal food, it is essential for them to have a calomel purgative every three or four days. Without such a precaution the stomach may be disordered and the gangrene spread; but both these evils are avoided in curable cases if the precaution be observed.

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* Vol. i. pp. 181, 195.

It may be worth while to add a word on the method of overcoming the offensive odour which is emitted by the gangrenous parts. Dry powdered charcoal freely sprinkled amongst the cotton wool intercepts very much of the noisome exhalation; but a few scales of pure iodine are still more effective for the purpose. Some iodine, contained in chip boxes, and covered with muslin instead of a lid, seems to attract and to destroy the odorous emanations, acting more powerfully than chlorine or any other disinfectant, and being far more convenient in use. The suggestion is from Mr. Hoffman, of Margate.

Should the gangrenous limb be amputated? Surgical experience and reasoning both prompt a general reply in the negative. In many cases, the obstruction of the artery is higher than the site of the proposed operation, as, for instance, in the iliac arteries or the aorta. Amputation in such circumstances can only be done below the cause of the gangrene, and in parts which are ill supplied with blood. Moreover, if the operation be performed on a level with or above the obstruction, as when the popliteal only is plugged, it is often unsuccessful; there still remains the constitutional exhaustion, the natural or the premature old age, or the disease of the heart, under the influence of which the patient has to rally from the shock of an amputation. And further, the instances are not few, especially amongst the younger subjects, in which the mortification ceases, and the dead parts spontaneously slough off. Except under special circumstances, therefore, amputation should not be performed. The various events are illustrated in the following two series of selected cases; the first showing gangrene in the aged, and the second in younger subjects.

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* *Lectures in Pathology and Surgery*, p. 368.

1. Gangrene attacked the arm of a middle-aged lady, who died exhausted in a few weeks, before the separation of the dead parts was complete.—A man, aged seventy-two, was attacked with inflammation at the back of the left hand, which ended in black dry gangrene. In six months death had spread, without causing pain, as far as the elbow; and in twelve months more, to the shoulder. The limb was hard, as black as smoked meat, and without cadaverous smell. In another month, the arm dropped off without hæmorrhage, and the wound healed without discharge. The man was alive and pretty well four years afterwards.*—Mr. Guthrie amputated low in the thigh for gangræna senilis, extending to the knee. The femoral artery was plugged at the groin. The stump did not slough; but the patient, an elderly lady, after a partial recovery, sank exhausted before it healed.†—Mr. Langstaff amputated a thigh for mortification of the leg in a man aged seventy-five. All the vessels were ossified, and could not be tied so as to stop the flow of blood. The patient, already much exhausted, died within twenty-four hours.‡—Dr. A. P. Thomson reported a case of amputation in the thigh for dry gangrene of the leg in a woman aged sixty-five. The arteries were pervious to the popliteal. The patient sank on the third day.—A man, aged seventy, died seven weeks after amputation in the thigh for gangræna senilis. It was unnecessary to tie any vessel in the operation; all were already plugged.§—Amputation in another case was survived for a time, but the soft parts took on no reparative action; they shrank and retracted from the end of the femur, and the patient died.—Mr.

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* Alix, Altenburg, 1778; quoted from Mason Good, *Medicine*, 1st edit. vol. ii. p. 919.

† Hunterian Museum, 141.

‡ *Med.-Chir. Trans.* vol. vi. p. 193.

§ Hunterian Museum, 2822.

James, of Exeter, amputated in the thigh for senile gangrene. The operation was followed by "constant tremor and subsultus, muttering delirium, and the sweat of relaxation;" yet the patient, a man of sixty-eight, eventually recovered.*—Some successful cases of amputation in senile gangrene were related in a discussion at the Royal Medical and Chirurgical Society of London, in 1853. Mr. Garlike, of Rickmansworth, had removed the thigh, near the trunk, four months after the commencement of gangrene at the toes, the patient in the course of his disease having likewise suffered from suppuration in the leg and in the knee-joint. Mr. Adams had seen a man, over sixty years of age, recover after a similar operation. Such cases are, however, extremely rare, and cannot be accepted as establishing a general rule of practice. Under peculiar circumstances, as in Mr. Garlike's case, amputation may be performed; but all that the other cases appear to show is, that the operation may possibly not be fatal in a few instances in which the strength of the patient is not much reduced, and the gangrene has existed for an unusual length of time. These, however, are just the few cases which may be capable of a spontaneous separation of the dead parts; the great majority of cases of extensive senile gangrene end in death, whether the limbs are amputated or not.

2. Two cases of gangrene of the lower extremity, in comparatively young subjects, have recently proved fatal in the Middlesex Hospital; the one under the care of Dr. Stewart, the other of Dr. Goodfellow. The heart, and the whole of the arteries implicated in its disease, have in each case been preserved as one continuous preparation, which exhibits at a glance the pathology of the occurrence: vast fragile polypi in the left cavities of the heart, and detached fragments of the cardiac mass plugging several of the arteries. In neither case had the ulcerative process deeply severed the dead and living parts.—A seamstress, aged seventeen, ill nourished, had acute spontaneous gangrene of the foot and the whole leg. There was no pulsation in the femoral artery. After amputation, the stump and the groin sloughed, and the patient died. But one small artery needed a ligature in the operation, and the iliac artery was found plugged.†—A native Christian of Salsette, aged thirty-five, was affected with spontaneous gangrene of the arm, and in eighteen days ulceration had deeply separated the dead and living parts at the elbow, and had extended along the integu-

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* James *on Inflammation*, 1832, p. 552.

† *New York Journal*, Sept. 1854, case 6.

ments half way to the shoulder. The limb was amputated about four inches below the shoulder-joint, and the man recovered.*—My colleague, Dr. Seth Thompson, requested me to see a girl, of nineteen or twenty years of age, whom he had admitted into the Middlesex Hospital, on account of a disease of the heart. Her illness had commenced with rheumatism, and in the course of it endocarditis, and subsequently pericarditis, had supervened. When I first saw her, she had loud mitral and aortic murmurs, acute adhesive inflammation of the right posterior saphena vein, and a red, tender, and exquisitely painful swelling at the lower third of the right leg. This inflamed patch had not suppurated; but the pain in it was intense, and quite destroyed her rest. She was pale, emaciated, fretful, and desponding. I made an incision into it, which relieved her; and after a few days a slough of fascia separated, and the wound healed with remarkably little suppuration. Inflammation was next observed in the left posterior saphenous vein. Anasarca followed, not only in the left leg, but also in the right; and the face became puffy. After a fortnight of great pain and much general depression, the left foot and leg became cold and dusky, and the ends of the toes shrivelled and turned black. Complete gangrene of the lower half or two-thirds of the leg ensued, and a line of demarcation formed, and deepened day by day. At length, when nothing remained to divide but the bones and a part of the tendon of the gastroenemius, I separated them, and removed the fœtid limb. The stump had nearly healed when she left the hospital.—A gangrenous leg was removed by amputation in the thigh from a puerperal woman, aged twenty-five. Not a drop of blood flowed at the operation, and the patient died the next day. In another patient, aged thirty-nine, gangrene of the foot took place after parturition, the thigh was amputated three months after the delivery, and the patient recovered.†—A man, aged thirty, suffered an "epidemic malignant fever," which brought on a mortification of the left foot. When ulceration was going on about two inches above the ankle, the leg was amputated below the knee. No blood flowed in the operation; but the stump suppurated healthily, and the man got well.‡

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* Hunterian Museum, 2835.

† *Simpson's Obstetric Memoirs*, edited by Drs. Priestley and Storer, vol. ii. pp. 46, 47, cases 23, 25.

‡ *Medical Observations and Inquiries*, 1764, vol. ii. p. 152.

ARTERITIS.

Inflammation of the aorta appears to have occurred in the practice of some physicians, and to have been traceable to the influence of cold. One such instance mentioned to me by my colleague, Dr. Goodfellow, followed upon a young man's lying for a long time upon his chest on wet ground. But the cases formerly described by Surgeons as primary inflammation of arteries appear, by the light of later research, to have been due to the previous impaction of a plug, and the forcible distension of the vessel as the plug was driven further and further along the tube. Inflammation of an artery, and even suppuration, may then take place, as has been described in the previous section of this essay. Upon the cases in which long portions of artery are found obliterated and converted into fibrous cords, no further observation needs to be offered than that no evidence of any previous arteritis is even adduced, and that the same result sometimes follows the application of a ligature.

CHARLES H. MOORE.

ANEURISM.

PATHOLOGY.

An aneurism is defined to be a tumour containing blood, and communicating with the cavity of an artery. Thus in every aneurism there are two parts to be considered, the sac* and its contents. The sac is formed either by the vessel itself, dilated from disease, or by the condensed soft parts in the neighbourhood.

The various classifications of aneurism now in common use are based upon varieties in the anatomy of the sac. The most natural nomenclature appears to me to be that which calls an aneurism formed by the coats (one or more) of the artery a true aneurism, and one formed by the surrounding cellular tissue a false aneurism. Unfortunately the term 'true aneurism' was applied by the older authors to a tumour in which all the coats of the vessel were dilated, while they called one in which only one of the coats formed the sac 'a false aneurism;' a very inappropriate name, inasmuch as such aneurisms form the majority of those met with in practice, while the term 'false' appears to convey the idea of something exceptional and peculiar. It is undesirable to complicate the matter still further by the attempt to introduce fresh terms. I shall therefore adhere to the old nomenclature in spite of my opinion of its incorrectness; merely observing that these anatomical refinements are of very little importance in practice; that no one troubles himself as to how many coats of the artery enter into the formation of a sac, or has any means of forming an opinion on the point before dissection. But it is a matter of great importance whether the blood is contained in a sac or no, whether that sac is or is not perfect, and whether the aneurism is of spontaneous or traumatic origin.

The term 'diffused aneurism' is also, I must confess, an inappropriate one as used to describe a tumour in which the sac is formed out of the cellular tissue; since such a tumour is as distinct and circumscribed as if the sac were formed by the vessel itself; and accordingly in many works an aneurism is said to be diffused when the sac has given way. But such an affection is equally well or better described as 'a ruptured aneurism.' The term 'diffused,' at any rate, serves to remind us that the blood was once diffused among the neighbouring parts, though it is now encysted; but as it is liable to be confused with the same term as used by other authors to designate extravasations from rupture, I shall prefer to use in the sequel the name 'consecutive aneurism' for such aneurisms as have the sac formed out of the tissues external to the vessel. In order as far as possible to avoid ambiguities, a table is subjoined, showing the nomenclature adopted in this essay, as contrasted with that hitherto common in France and England; M. Broca's treatise being used as an example of the former, and the chapter on Aneurism in Mr. Erichsen's *Science and Art of Surgery* for the latter. (See the Table opposite.)

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* Some authors speak of extravasations of blood among the tissues of a limb, from the giving way of an artery, as 'diffused aneurisms;' but this appears to me an error. I should term this lesion 'a ruptured artery.' The distinction, as I hope to show, is not a trivial one.

The kinds of aneurism to be described below are as follows:

1. Common or encysted aneurism, subdivided into
    (*a*) Fusiform aneurism, or aneurismal dilatation.
    (*b*) True aneurism.
    (*c*) False aneurism.
    (*d*) Consecutive or diffused aneurism.
2. Arterio-venous aneurism, subdivided into varicose aneurism and aneurismal varix.
3. Cirsoid aneurism, sometimes called arterial varix. Aneurism by anastomosis will also be considered under this head.
4. Dissecting aneurism.

1. By common or encysted aneurism is meant that variety of the disease, embracing by far the greater number of cases, in which the tumour is formed of a single cyst, communicates only with a single artery, and is limited to a single point of the course of that artery. Some of the subdivisions of this affection are practically very different from each other, while between others the difference is unimportant, and in fact usually inappreciable during life.

In the *aneurismal dilatation*, or *fusiform aneurism*, the whole circumference of the artery has yielded to the force of the circulation for some considerable length of the vessel, and so a tumour has been developed, of an elongated or somewhat cylindrical shape, continuous with the cavity of the artery at each end. The coats of the vessel are generally much thinned and highly atheromatous. This form of aneurism hardly ever contains much clot. It is of more common occurrence in the aorta, but rare in the arteries of the limbs; the most usual situations below the aorta being the innominate, the top of the common carotid, and the inguinal portion of the external iliac and femoral (p. 328). Some authors separate the

Terms used in this Essay.	Broca.	Erichsen.
I. Common or encysted aneurism. The tumour forming a single sac, communicating with a single artery at a single point. Subdivisions:	Circumscribed aneurism.	
(*a*) Aneurismal dilatation or fusiform aneurism. The sac formed by all three coats of the artery dilated over a great extent.	This is excluded from Broca's classification.	Fusiform or tubular aneurism.
(*b*) True aneurism. The sac formed by all the coats of the artery dilated at only one point.	True aneurism.	True sacculated aneurism.
(*c*) False aneurism. The sac formed by only one of the coats of the artery.	Mixed external aneurism; subdivided into *sacciform*, *fusiform*, and *dissecting*.	Circumscribed false sacculated aneurism.
(*d*) Consecutive or diffused aneurism. All the coats of the vessel have given way, and the sac is formed out of the neighbouring parts.	False, or encysted aneurism; subdivided into primitive and consecutive. Cystogenic aneurism; formed by a cyst developed in the thickness of the walls of the vessel, and afterwards communicating with its cavity. This is not recognised in either of the other classifications.	Diffused false sacculated aneurism, under which he also includes extravasations without a sac—our ruptured aneurism or ruptured artery.
II. Arterio-venous aneurism, formed by a direct or indirect communication between an artery and a vein. Subdivisions:	Arterio-venous aneurism.	
(*a*) Aneurismal varix; in which the communication is direct, no tumour being formed.	Aneurismal varix, or simple phlebartery.	Aneurismal varix.
(*b*) Varicose aneurism; where the communication between the vein and artery is through the intervention of a tumour.	Varicose aneurism. Two forms described; the one in which the tumour is formed by a dilatation of the vein (varicose aneurism by dilatation); the other in which the sac is a new formation—encysted or false consecutive varicose aneurism.	Varicose aneurism.
III. Cirsoid aneurism; formed by the convolutions of a single dilated artery.	Arterial varix.	Arterial varix.
IV. Dissecting aneurism; an affection of the vessel occasioned by ulceration of its lining membrane, and effusion of blood between the coats.	Dissecting aneurism, considered by Broca as a variety of false aneurism. Broca describes two kinds of 'diffused' aneurism, by which he means aneurisms without a sac. This, according to us, is a contradiction in terms. Broca's first form of diffused aneurism is described in this work as 'rupture of an artery;' his second as 'rupture of an aneurism.'	Dissecting aneurism. The same remark applies to Erichsen's classification.

aneurismal dilatation entirely from the category of aneurisms, and treat of it as a distinct disease; but no pathological distinction can be made between this and other forms of dilated artery which would not be subject to endless exceptions and modifications, and in practice this affection is often indistinguishable from the 'true' aneurism.*

True aneurism is defined to be a circumscribed dilatation of an artery in a part only of its circumference, in which all three coats of the vessel are dilated to form the sac, while in a (so-called) *false* aneurism the two internal coats have given way and disappeared, and the sac is formed only by the external, or cellular, coat. The true aneurism, like the aneurismal dilatation, of which it may be regarded as a variety, is much more common in the aorta than in any other vessel; so much more so that Scarpa denied that true aneurism exists in any other artery. It is difficult, however, to refuse credence to the numerous authorities who have described the dissection of small incipient true aneurisms in which the several coats could be actually demonstrated; but at a later period they become consolidated together at the neck of the sac, and the internal layers cannot be followed further, having been worn off by friction, if they were ever present: at this period, therefore, there is no appreciable difference between one aneurism and another as to their mode of formation. Even if the two internal coats can be followed for some little distance beyond the opening into the aneurism, this does not prove that it is a true aneurism, since the part of the internal coats which can be traced may be merely that which would have lined the opening, and which has now been everted into the sac. The presence of a smooth, shining membrane lining the sac is no proof that the tumour is a true aneurism, since such pseudo-epithelial laminæ are very often found in new formations,† and particularly where constant motion has been taking place. So that it is impossible to perceive any difference between true and false aneurisms at the time at which they generally come under observation; and it is not worth while to say more on the subject, beyond stating that the true become false as they grow; and expressing an opinion, founded on the manner of their origin, that false aneurisms are far the most common.

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* Some amount of dilatation, associated usually with atheroma, is constantly met with in the arteries of persons advanced in life; but this hardly constitutes a tumour, and so does not deserve the name aneurismal. The arteries also become tortuous as well as dilated in elderly persons of relaxed fibre, and it seems, from the account of a preparation by Mr. Coulson (*Path. Soc. Trans.* vol. iii. p. 302), that this condition sometimes simulates an aneurismal tumour. The patient was a woman aged 88, who for some years before her death had had a pulsating tumour, the size of an orange, just above the right clavicle, in the situation of the carotid. It had been taken to be aneurismal, but on dissection it was found that "the vessels arising from the aorta were elongated, and considerably dilated; and the tumour consisted of a reduplication of the common carotid and of indurated cellular tissue around it."

† See Prescott Hewett, in *Med.-Chir. Trans.* vol. xxix. p. 80.

Another form of false aneurism is described by authors of credit, and must therefore be noticed here, although its reality is doubtful. It is sometimes called 'hernial' aneurism, and the sac is formed by a projection, or hernia, of the two inner coats, or some portion of them, through a rent or an ulcerated opening in the external tunic. Whether the cases which have been put on record really prove the existence of this affection, must be left to the reader to decide for himself. It is a point rather of curiosity than of practical interest.*

The other form of encysted aneurism is the *consecutive* or *diffused*, in which all the coats of the artery (or, as frequently happens, the sac of a previous aneurism) have given way, and the blood is effused into the cellular tissue. The latter soon becomes condensed, and forms, with the muscles, ligaments, viscera, or bones in the neighbourhood, a sac for the blood, frequently distinguished from those of the previous varieties by being multilocular. The great majority of aneurisms are, if the terms be strictly construed, of the consecutive form; since few tumours of long standing will be found in which some part, at any rate, of the sac has not been borrowed from surrounding tissues. I would wish, at the risk of being accused of repetition, again to remind the reader that the term 'diffused aneurism' is very often applied to a *ruptured* aneurism, and even to a ruptured artery, *i.e.* to cases in which the blood is poured out into the cellular tissue, and infiltrates a great part of the limb without the formation of any sac. But I think that I shall be able to show reasons for saying that it is more correct, and is of considerable practical importance, to separate these cases altogether from cases of aneurism properly so called, and to limit that term to tumours provided with a sac.

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* There is a preparation in the museum of the College of Surgeons intended to show this form of aneurism. Mr. Erichsen, however, reports, as the result of his examination of this specimen, that he believes the external coat not to have been originally deficient, but to have been dissected off. *Cooper's Surgical Dict.*, 8th edition, 1861, p. 140; and in this opinion I quite concur. The line at which the external coat has been cut away, is distinctly marked all round the neck of the sac. M. Broca expresses his disbelief in the reality of this affection.

Such are the varieties of common aneurism, classified according to the anatomy of the sac. Other principles of classification have been proposed. Thus, some Surgeons prefer dividing aneurisms, according to their form, into tubular, sacculated, and dissecting;* and frequently aneurisms are named, according to their cause, traumatic or spontaneous. Each method of classification is occasionally useful; but the anatomical arrangement is most generally adopted.

Causes of aneurism. In general terms it may be said that any thing may be a cause of aneurism which destroys the balance that ought to exist between the expansive force of the circulation and the reaction of the wall of the artery, so as to make the former preponderate. But none of the ordinary events which are looked upon as exciting causes of the disease, can produce it without a predisposing cause in the condition of the artery itself. This condition is, in the great majority of cases, the result of *atheroma;* but on that state of the arteries enough has already been said, and the reader is referred to the previous section. Any other cause which produces a partial atrophy of the artery renders it liable to dilatation at the atrophied part: Vidal† remarks that the accidental exposure of an artery which ought to be deep seated may induce aneurism, both by weakening the coats of the vessel, and by depriving it of the support of the soft parts. Unnatural and long-continued pressure may produce the same effect. Thus, a case is recorded in which the pressure of an exostosis produced aneurism.‡ The frequent occurrence of aneurisms in both popliteal arteries strikingly proves the origin of the affection in disease of the arterial system; the same thing is even more strongly shown by a case which is recorded of the formation of a popliteal aneurism in one ham, while the man was in bed for the treatment of an aneurism in the opposite ham. In extensive disease of the arteries, a great number of aneurisms may form, constituting what is called the 'aneurismal diathesis.'§

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* Luke, in *Lond. Med. Gaz.*, May 9, 1845; Erichsen, in *Cooper's Surgical Dictionary*, 8th edit.

† *Traité de Pathol. externe*, 1851, vol. i. p. 645. The instance which he gives is one of exposure of the femoral artery in hospital gangrene.

‡ Roux, *Quarante Années*, &c. vol. ii. p. 131.

§ Broca (*Des Anévrismes et de leur Traitement*, p. 52) instances, among other cases of multiple aneurisms, one under the care of Pelletan, in which sixty-three were found in the same body.

It often happens, however, that aneurisms are found in arteries which appear healthy in all other parts of their course; and this seems to be more frequently the case the farther the disease is from the heart. In these cases the nature of the predisposing cause is unknown. It has been alleged that mercury and syphilis predispose to aneurism; but the assertion appears gratuitous. The abuse of ardent spirits is certainly an exciting cause, and may possibly produce some weakness of the vessels, so as to entitle us to consider it also as a predisposing cause. It is worthy of notice that the disease is almost unknown in early life;* that external aneurisms (*i. e.* aneurisms of the limbs) are very rare among women, especially in the higher ranks of life; and that such aneurisms are found most commonly upon those arteries which are most affected by the movements of the joints; while aneurisms generally are most common at those points where the flexure, or the division of a large artery, opposes some sort of check to the blood-stream. The arch of the aorta, especially at the dilated portion called the 'sinus magnus,' and at the transverse bend, is the most familiar example of aneurism occurring at the flexure of an artery; while the dilatation of the end of the common carotid, the common aneurism of the lower part of the popliteal, and the tumours which affect the cœliac axis or the abdominal aorta usually at the root of one of its branches, will illustrate the effect of division. The aorta, popliteal, and axillary artery seem most liable to disease, as being the most constantly subject to stretching, and the two latter to forcible rupture. The constant impulse of the blood-stream against the arch must keep the lower part of the aorta in more active motion than any other part of the arterial system. The influence of forcible motion on the popliteal artery is shown by an experiment of Richerand.† On a dead subject let the bones of the extended leg be forcibly driven down into the ham till the ligaments are heard to crack. The middle and internal coats of the popliteal artery will be found torn. It is true that the accidents commonly cited as causes of aneurism are not so severe as this rough proceeding; but slighter injury to the artery probably occurs, and lays the foundation for subsequent dilatation. Again, the heart is often hypertrophied, as the consequence either of disease or of the habits of life of the patient; and where the artery is weakened by any of the above causes, it can no longer resist the increased impulse. Hence aneurism is regarded, with at any rate much probability, as a mechanical effect of the wearing out of the artery by use; the circular muscular fibres which constitute the strongest part of the wall of the vessel being, according to this theory, stretched, and partially separated. The fact that aneurism affects the systemic arteries only, *i.e.* only those vessels which convey red blood, has led some authors to believe that the formation of these tumours may depend, in some unknown manner, upon the quality of the blood conveyed by the artery. With our present knowledge of vital chemistry, it would be absurd even to affect to give an opinion upon the possibility of this. It seems quite sufficient to state that the pulmonary system receives the force of the right ventricle only, which is seldom hypertrophied, and which, at its strongest, is perhaps incapable of generating the expansive force necessary to produce aneurism.* In some persons affected with the so-called 'aneurismal diathesis,' the whole arterial system shows an extraordinary tendency to aneurism, without, as is said, any visible anatomical peculiarity in the vessels; but in ordinary cases of this diathesis the vessels are evidently soft and weak.

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* A few cases are, however, on record. Mr. Hutchinson found an aneurismal cavity connected with the aorta of a child four years of age, which he was inclined to attribute to the ulceration of a tuberculous abscess into the artery (*Path. Soc. Trans.* vol. v. p. 104). Mr. Syme has operated for aneurism at the age of nine (*Lond. and Edinb. Monthly Journ.* 1844); and a case of rupture of the aorta in a child æt. seven and a half years, probably preceded by the formation of a small aneurism, is recorded by Dr. Armitage (*Path. Soc. Trans.* vol. ix. p. 85).

† *Nosog. Chir.* vol. iv. p. 73. Hodgson *on Diseases of the Arteries and Veins*, ed. 1815, p. 64. In repeating this experiment, I have found that this is only occasionally true. I have sometimes found the artery entire; and on one occasion the external coat was somewhat lacerated, while the others remained entire.

When, by any of these predisposing conditions, the wall of the vessel is sufficiently weakened, it will give way at the weakened part to the force of the circulation, and all the more surely if that force is temporarily increased by any unusual circumstance, which thus becomes an exciting cause. Hence, perhaps, the frequent occurrence of aneurism in persons of dissipated lives, and in persons who follow laborious occupations; by which not only is the heart's action unduly increased from time to time, but also the arteries of the limbs are exposed to frequent shocks. Hence violent mental emotion sometimes gives rise to aneurism. Two cases of aneurisms of the abdominal aorta, dating in each case from the time of the patient's receiving sentence for a criminal offence, have come within the experience of Mr. Rendle, Surgeon to the Brixton Prison.* Occupations which necessitate constant exercise of a limb, and frequent strains upon its joints, act both as predisposing and exciting causes of aneurism in the arteries lying near such joints. Popliteal aneurism seems to be caused in very many instances by the giving way of the circular coat of the vessel under the alternate movements of forced extension and violent flexion, to which that artery is exposed in the movements of the knee. Suppuration near an artery may lead to the formation of a consecutive aneurism, the wall of the vessel being perforated by ulceration, and the blood admitted into the sac of the abscess. This seems to be a very rare event; but suppuration around an artery may also act as a predisposing cause, by denuding the vessel; as has been already pointed out. Unmistakable instances, however, of abscesses converted into aneurisms are on record. Mr. Liston's case is well known,† in which he opened a cyst communicating with the internal carotid artery, believing it to be an abscess, and in which he was obliged, in consequence of the gush of blood that followed the puncture, to place a ligature on the common carotid. The patient died of secondary hæmorrhage, the result of the operation; and on post-mortem examination Mr. Liston found reason to believe that the disease was originally an abscess which had established a communication with the artery. Whatever may be thought of the real nature of the tumour in that case, there can be little doubt that several of the other cases which are related in Mr. Liston's paper were genuine instances of communication between abscesses and arteries.* These abscesses may be the result of struma, cancer, or common inflammation. In the 34th volume of the *Medico-Chirurgical Transactions* is a very interesting case by Mr. Dixon, in which a hydatid cyst, having been laid open, sloughed, and so established a communication with the subclavian artery. The patient died of hæmorrhage. This is the ordinary result in cases of ulceration penetrating arteries. No aneurism is formed, since there is an open wound. But, in the rarer cases, such as those above, the suppuration proceeds subcutaneously, and a consecutive aneurism is formed. Possibly Mr. Liston's case may have been an example of this event; but the diagnosis must be allowed to be doubtful. The following instance was one in which the artery gave way without any known cause, there being no clear history of abscess, nor any violent effort or injury to account for the laceration. A man aged twenty-nine was admitted into St. George's Hospital for a large purple swelling at the back of the pharynx, accompanied by swelling and much discoloration on the front and left side of the neck. Two days before admission, the patient while kneading some bread felt a stabbing pain near the hyoid bone. In three hours' time the throat was so swollen that he could not swallow food, and dyspnœa came on. After a short stay in the hospital, the diffused swelling of the neck became circumscribed, hard, and smaller. There was evident pulsation of the tumour, with a whirring sound, which only became perceptible as the tumour diminished in size and became harder. The patient went on well for a month, the tumour becoming reduced to the size of a walnut, when suddenly it increased in size and extended in various directions. The general beating of the tumour gradually disappeared, leaving merely a line of pulsation in the course of the carotid. Great difficulty of swallowing followed immediately; the tumour became more and more tense, and the symptoms increased. The patient died of dyspnœa six days after the sudden increase in the tumour. The parts are in the hospital museum. In the preparation, immediately below the bifurcation of the carotid artery is a small opening in the vessel surrounded by a few minute patches of atheroma. There is a large pouch formed by the cellular tissue and fibrin of the extravasated blood, which completely pushes the larynx and trachea over to the right side, and encroaches much on the cavity of the larynx. There is no distinct rupture perceptible in the sac, but it is extremely thin at one point. It is formed chiefly by blood-clot, the fibrous investment of which is very thin.

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* A case of aneurism of the pulmonary artery is on record in which the ductus arteriosus was pervious, and so red blood was admitted into the artery. But it is not impossible that the force of the left ventricle might have been reflected along the open duct. On the connexion between the quality of the blood and the deposition of atheroma, see the section on that head.

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* Mr. Rendle has favoured me with the following note: "A strong healthy woman, five feet eight inches high, who had never before been in prison, received a sentence of transportation for life. *Immediately* on receiving sentence, and whilst standing at the dock, she almost fainted from terror, was suddenly seized with severe pain in the epigastric region, and fell into the arms of an attendant. The pain in the epigastric region never entirely ceased; and just six weeks after, a pulsating tumour of *small* size was readily to be felt. This increased in size, until it was as large as the closed fist. She lived for three or four years, being constantly kept in bed and under treatment, and then passed from under my care. I have been unable to find out the result. This case was so clearly traceable to the shock consequent on receiving a heavy sentence, as to leave no reasonable doubt of the immediate cause of the disease.

"The second case was also an aneurism of the abdominal aorta at the cœliac axis, and came on after receiving a severe sentence, though I could not trace it so distinctly to the sentence as in the first case. When I discovered this tumour,—the woman only complained of obscure pain in the part, and was at her work when I saw her,—it was about the size of a small orange. I sent her at once to the infirmary, and had her put to bed. *Twelve hours* after being in bed, the aneurism ruptured, and she died in forty-eight hours. I made a post-mortem examination. Both patients were women between thirty and forty years of age, and otherwise healthy."

† *On a Variety of False Aneurism*, Lond. 1842. An interesting case of fatal hæmorrhage from communication between an abscess in the neck and the aorta is recorded by Mr. Busk, *Med.-Chir. Trans.* vol. xxix. p. 297.

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* It may not be out of place to notice here the extraordinary omission, in Mr. Liston's paper, of any reference to auscultation as a means of diagnosis. He admits that, before he made his puncture, he had received "a hint that the tumour might in some way be connected with the carotid;" yet he never seems to have listened for a bruit. Had he done so, there can be little doubt that it would have revealed the existence of a communication with the artery.

It seems probable that the impaction of a clot of fibrin in the artery may lead to its dilatation behind the obstruction, and thus to the formation of an aneurism. Mr. Tufnell has put on record* a remarkable case, in which a pulsating tumour formed in the ham, in a patient who was dying from rheumatic disease of the aortic valves. The tumour subsided with simultaneous enlargement of the collateral branches; and after death the artery was found plugged with fibrin and somewhat dilated. In this case it seems clear that the artery, being healthy at the part where the clot became impacted, yielded to the force of the (hypertrophied) heart to such an extent as to form a tolerably large pulsating tumour, but that, as the collateral circulation enlarged, it was enabled nearly to recover its healthy dimensions. If the same accident were to take place in an artery enfeebled by atheromatous degeneration, no doubt the aneurism would go on increasing. The objection which has been urged against this mode of formation of aneurism, viz. that aneurisms do not form on arteries suddenly obstructed by ligature, is an unsound one, since they do so form, although rarely.† It is even possible that aneurisms may sometimes be occasioned, in a healthy vessel, by the impaction, or embolism, of a clot of fibrin.‡ To these various exciting causes some have added pressure upon the artery, and consequent obstruction of the circulation, by tendinous or ligamentous bands crossing it below, or by the action of muscles; instancing the pressure of the fibrous arch from which the soleus arises as a cause of popliteal aneurism.*

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* *Dublin Quart. Jour.*, May 1853.

† See Wounds of the Vessels, vol. i. p. 677.

‡ See a case reported by the writer in the *Path. Soc. Trans.* vol. xii. p. 61.

Such are the causes, predisposing and exciting, of spontaneous aneurism. The term 'traumatic aneurism' is usually intended to include only those instances in which aneurism follows a wound known to have been inflicted upon an artery; and this wound is, of course, in the great majority of cases an open one. In such a case, the wound in the skin usually unites under pressure; the issuing current of blood prevents the lips of the orifice in the vessel from coming together, while the reaction of the neighbouring parts, the pressure of muscles and fasciæ, and the supervention of syncope from loss of blood, prevent the unlimited infiltration of blood into the cellular tissue, and the death of the patient from that cause. The blood, being thus hemmed in, quickly loses its more fluid part by absorption, and becomes a more or less solid body, and is encysted in the same way as other foreign substances. In other cases no skin-wound exists; of which the most common instance is the wound of a vessel by a fractured bone, and here the process of formation of the aneurism is the same. The form of aneurism is, therefore, the consecutive; and, *vice versâ*, most consecutive aneurisms are traumatic. Many are, however, spontaneous, being caused either by ulceration perforating an artery, as in Liston's case, or (which is very common) from the rupture of a previously existing aneurism. It has been above noticed that many, if not most, of the aneurisms which Surgeons have to treat are, in one sense, traumatic, as having been probably caused by injury; the term is, however, usually restricted to those cases in which the vessel is known to have been penetrated, and will be so used in the sequel.

Progress of aneurism. When once formed, the tumour is likely to go on increasing as long as the conditions subsist in which it originated. These conditions vary so much, according to the state of the sac, of the parts around it, and of the blood which it contains, that it is impossible to form a clear idea of the disease without studying each of these separately.

The changes in the sac depend in a great measure upon the position and size of its communication with the artery, and somewhat upon the direction in which the sac grows and the part of the artery on which the opening is seated: thus, sometimes the opening is situated on the concavity of the curve of a vessel, so that the artery is stretched over the tumour; more frequently on the convexity or bend of the artery; sometimes the arrangement of the neighbouring parts is such that the tumour can only grow in the opposite direction to the current of blood, or that pouches are formed in it. It would carry us beyond our limits to refer to instances of such arrangements, and to point out the variations in growth and progress to which they seem to have given rise. In a fusiform aneurism, in which the orifices of exit and entrance are free, the lateral pressure upon the sac cannot be severe. Hence these aneurisms advance slowly, and do not readily burst. On the other hand, pedunculated aneurisms, in which the sac communicates by a narrow channel with the arterial stream, are seldom found of large size, having usually burst before they attain any thing like the size sometimes reached by the aneurismal dilatation.* The reason of this fact, no doubt, is, that the impact of the stream of blood through the narrow orifice (supposing that orifice unobstructed) is concentrated more upon one point, instead of being diffused over the whole wall of the sac, as in the previous variety. Between these two extremes there are, of course, all possible shades of difference; but in every aneurism, properly so called, as distinguished from a mere dilatation, the pressure on the wall of the sac is much greater than the natural pressure of the heart. This may be illustrated by a reference to the scientific toy known as the hydrostatic paradox,† in which a small pipe communicates with a closed bellows, the pipe and bellows being filled with fluid. The smaller the opening in the bellows, the greater is the pressure on its walls. An aneurism standing out like a bud from the artery, and communicating with it by a small opening, would bear a resemblance to this machine, though not a strictly accurate one, since regurgitation would go on in the aneurism, which is not the case in the bellows. In addition to this it may be remarked, that these small openings are sometimes, perhaps always, formed by the giving way of small portions of the atheromatous wall of the vessel. Such small atheromatous patches are met with in long tracts of healthy artery, where the wall is thin and weak, and where, therefore, a small and weak sac soon forms, and is liable soon to burst.

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* Verneuil, *Bulletin de la Société Anatomique*, 1855, p. 268.

It does not necessarily follow, however, because the wall of an aneurism gives way, that the tumour therefore bursts. The process is usually quite a gradual one; and as the old wall is thinned and absorbed, inflammation proceeds in the tissues surrounding the sac, and, by condensing them, supplies the tumour with a new envelope. On minute examination of most large aneurisms, it will become evident that portions of their sac are formed by cellular membrane, muscles, and other tissues, which have originally been distinct from the tumour. In other cases, and especially when the tumour has perforated a bone, its sudden increase marks the occurrence of a large rent in its walls, and the supervention of a large consecutive aneurism upon the original disease.

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* Rokitansky, *Path. Anat.* Syd. Soc. vol. iv. p. 280.

† Or hydrostatic bellows. The machine will be found described in most treatises on hydrostatics; *e. g.* that in the *Encyc. Brit.* 8th ed. vol. xii. p. 81.

Another very important element in the condition of the sac of an aneurism, is the nature of the parts by which it is surrounded; since, when the tumour meets with the resistance of bone or other dense tissue, the sac is absorbed or worn away; whilst, when it presses upon organs which are very sensitive, or whose function is important, reaction and inflammation are soon excited by the pressure of the increasing tumour; and in such cases, if the inflammation does not pass a certain limit, perhaps consolidation may ensue, otherwise ulceration will take place. A singular complication of aneurism is where the tumour projects into the cavity of a neighbouring vessel, usually the pulmonary artery or one of the cavities of the heart. Here ulceration seems to take place early, unless the pressure of the sac produces death. When veins lie contiguous to an aneurism, they are usually closed by the pressure of the tumour. Cases, however, are on record in which an aneurism has burst into the cavity of a vein. This circumstance will be again referred to in the section on arterio-venous aneurism.

The changes which take place in the neighbouring parts are due either to the pressure of the tumour or to the inflammation which it excites. The growth of an aneurism is often so rapid, that the effects of its pressure are very striking. Veins are closed, nerves expanded and thinned, muscles stretched and wasted, bones roughened or perforated, and even the skin itself sometimes so atrophied as to give way. When aneurism produces irritation in the surrounding parts, the latter may slough or suppurate.* The sac is also usually involved in the action, and then the aneurism is opened by the separation of the slough, or the bursting of the abscess. This is usually accompanied by fatal hæmorrhage; but it may lead to the spontaneous cure of the disease, as will be pointed out under that head. The great difference often observed in the progress of internal aneurism, according as it presses upon a mucous or a serous surface, has been well shown by Dr. Gairdner.* The hæmorrhage produced by the ulceration of an aneurism into a mucous cavity, as the pharynx, œsophagus, or intestine, usually proceeds from a minute orifice, and occurs by small quantities at a time, the opening being very liable to obstruction by a clot; while the opening on a serous surface, as the pleura or pericardium, is often, perhaps usually, a large rent, through which rapidly fatal hæmorrhage takes place.† Surgical aneurisms do not very often come into contact with either of these classes of membrane, but the synovial cavities bear a great analogy with the serous, in this as in other respects; accordingly, hæmorrhage into a joint is generally rapid and profuse. Two cases of great interest will be found in Dr. Gairdner's treatise, in which the spontaneous opening of an aneurism through the skin was followed by healing of the orifice, and in one case possibly by a cure of the disease; and other instances are on record in which aneurisms have been accidentally opened without ill effects—nay, in some with good effect, from relief of the tension. It is more usual for an aneurism to communicate with one of the large mucous cavities of the body, than with any other part. Then the progress of symptoms usually is, that a slight hæmorrhage occurs, which both weakens and alarms the patient to some extent. The bleeding then ceases, whether from syncope, from displacement of parts creating obstruction, or from plugging of the opening by displaced clot; but this cessation is temporary: the fissure reopens and enlarges, and the patient dies exhausted after a few recurrences of bleeding. Sometimes the bleeding occurs in such a situation,‡ or in such quantity, as to extinguish life in a moment; but these cases are usually under the care of a Physician.

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* Roux, *Quarantes Années*, vol. ii. p. 260, relates a case in which he believes that an abscess formed over an aneurism, and communicated with it. This case, however, must be allowed to be somewhat dubious. Another and much clearer case of an abscess forming over and opening into an aneurism of the aorta may be found in Broca, op. cit. p. 166.

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* *Med.-Chir. Trans.* vol. xlii.

† Mr. Obré relates a curious case, in which an aneurism ulcerated into the pericardium by three small openings, each of them only about large enough to contain two bristles. Death was rapid in this case; but had a similar ulceration occurred into the pleura, life might have been sustained for a considerable period, or the openings might have closed. *Path. Soc. Trans.* vol. iii. p. 307.

‡ See, in the *Path. Soc. Trans.* vol. x. p. 84, two cases in which aneurisms of the abdominal aorta burst, and the blood was effused around, and constricted, the œsophagus in one case, and the duodenum in the other.

Surgical aneurisms, when they burst, usually open under the skin or into a joint. In the latter case bleeding is generally copious, and the cavity becomes so much distended that pulsation is felt in it. The bursting of an aneurism subcutaneously is usually accompanied by great pain, and by rapid and gradually increasing hæmorrhage, producing faintness and syncope; but the symptoms and treatment of these accidents will be more fully considered hereafter.

Another termination of a growing aneurism, which is frequently met with in those affecting the extremities, is by gangrene, the result of pressure. This takes the case out of the category of common aneurisms, and it must now be treated like any other tumour producing gangrene. Aneurisms may remain stationary for a long period, though this is extremely rare. Sometimes, after the apparent cure of an aneurism, *i. e.* after it has ceased to pulsate and become stationary, it will again commence to grow, and the pulsation will recur; and in a case of this kind, which has furnished a preparation to the museum of St. George's Hospital, increase of size was noticed without any return of the pulsation.* In that case the artery had been tied above the tumour, and the increase of the latter, which was very marked, from the size of a hen's egg to that of the egg of an ostrich, and which continued during twelve months, led to the suspicion that the diagnosis had been mistaken, and the disease not aneurismal but malignant. However, the tumour became at last stationary and solid, and the cure lasted during the rest of the patient's life, about one year. After death, the accuracy of the original diagnosis was established. In this case the cause of the absence of pulsation was obscure; but pulsation may sometimes be absent merely in consequence of the position of the opening; and in some cases no bruit may be audible, the orifice being at the deep surface of the tumour, and the force of the stream probably broken by clots. Such was the case in a woman under Mr. Vincent's care at St. Bartholomew's Hospital, in whom an aneurism followed the occurrence of a longitudinal rent in the posterior tibial artery, on its anterior face. The sac being formed at the posterior part of the artery, the stream of blood seemed to enter it indirectly. Hence probably the absence of pulsation. Nor was there any bruit. The diagnosis, therefore, was only made, after a long course of treatment, by an exploratory incision, when amputation became immediately necessary. I am indebted to Mr. Moore for the notes.

The changes in the blood contained in the sac are even more important than those in its walls. They refer to the nature and amount of clot formed in it. It is this clot which, by strengthening the wall of the aneurism, enables it to resist the action of the heart, and so opposes further increase, and which, by its constant increase in size and density (fresh clot forming as the old contracts), encroaches upon and finally obliterates the cavity. As this is the only cure of which the disease admits, except by ablation or in the very rare case of spontaneous cure by sloughing, it is to obtain the deposition of an efficient coagulum that all the efforts of Surgeons and Physicians are directed in the treatment of aneurism.

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* Prescott Hewett, *Med.-Chir. Trans.* vol. xxix. p. 75.

In examining an aneurism after death, two kinds of blood-clot will be found in it. The one, which lines the sac, and is usually very firmly united to it, is tough, more or less decolorised and laminated, much resembling layers of different-coloured leather. The laminæ, and the differences of colour, obviously mark a gradual and successive deposition. This laminated coagulum is now frequently called, after Broca, 'active clot.'* The other kind is soft, amorphous, and red, something like currant-jelly, and is always found inside the former. This soft clot (otherwise 'passive clot') may be a mere post-mortem appearance; but it is no doubt often formed in aneurismal tumours during life. Its formation, however, is not a matter of the same importance as that of laminated coagulum; indeed, a too rapid deposit is to be deprecated, as leading to a delusive appearance of cure.† It is liable to be either melted or washed away by the circulation, and then the tumour, which seemed to be cured, begins to grow again.

It will be remembered that the first phenomenon of atheroma consists in the deposition, out of the fluid blood, of a fibrinous stratum on the wall of the artery. The commencement of coagulation in an aneurism bears, at any rate, a strong resemblance to this; but, unlike the formation of atheroma, it seldom, if ever, takes place where the sac is exposed to the full force of the blood. The least diminution of the circulation, however, as from pouches in the sac, from roughness of its walls, or from external causes moderating the impulse of the heart, will lead to the formation of tough fibrinous coagulum on the wall of the aneurism, though what is the exact physical cause of this coagulation is unknown. It seems to require for its commencement a diminution of the circulation, but not its entire stoppage; indeed it sometimes seems to go on less readily when the stream is stopped altogether. When once this tough fibrinous coagulum is formed, it has a tendency to propagate itself through the contiguous layers of blood until the whole sac is full, unless the stream of blood should be too strong for it; and when once formed, the clot acquires greater density, partly by the inherent power of contraction possessed by fibrin, partly because it is, as it were, hammered out by the impetus of the circulation. It is interesting to compare different parts of the same sac: here, fibrin accumulates in strata; there, all is worn away—the sac, the surrounding soft parts, the periosteum, even the bone. A careful study of the parts will generally prove this to be owing to the impact of the stream of blood, and to the resistance of the surrounding parts; the attrition to which the sac is thus subjected easily explains its absorption. In this process of absorption, it seems that the clot may also be involved; that is to say, that even laminated coagulum may, in some conditions of the sac, be removed,—an effect which can hardly be attributed to any thing but the action of the vessels of the sac upon it. But if the vessels of the sac can remove the clot, may they not also deposit it—that is, may not the laminated fibrin which lines the clot be an exudation from its vessels, rather than a kind of precipitate out of its contents? This is the opinion of some pathologists,* who consider the process as somewhat analogous to inflammation. But if it were so, the internal layers of clot ought to be the oldest, having been pushed inwards by the increasing deposit; now every-day observation of their colour and consistence proves that they are the most recent. The exact cause, however, of the formation of laminated clot must be allowed to be obscure. It is enough for our present purpose to know that in an aneurism such clots have the greatest possible tendency to form, and will form almost inevitably to some extent when the full force of the circulation has been withdrawn. Even in tumours which are rapidly increasing, it is usual to find coagula in parts where the stream has been less powerful.

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* The name does not seem a very well-chosen one, since it is rather the process than the clot which deserves to be called active. Looking at such a clot which has remained for years unchanged in a cured aneurism, one would be inclined to say that nothing could well be more *passive*.

† Very possibly, however, a moderate deposition of loose clot may be the first stage in the formation of the laminated coagulum; all that is meant in the text is, that the filling of the whole sac, or a great part of it, with loose clots, is often not so much an aid as a hindrance to the cure.

The nature of the connexion between the sac and its lining of fibrin, is another obscure point in pathology. M. Broca, in an interesting passage of his valuable work,* endeavours to prove that the laminated clot formed in an aneurism possesses a certain grade of vitality, however low. But the facts which he adduces to prove the vascularisation of such coagula do not appear strictly applicable to aneurismal clots. John Hunter and Blandin have injected clots in arteries after ligature, and Kiernan in a concretion forming in a vein below a tumour; but in both these cases there are evident sources of vascular formation, which do not exist in a cured aneurism; nor have I succeeded in meeting with any unequivocal proof that vessels pass between the sac and its lining of coagulum, nor with any facts which prove that such clots ever share in the vital actions, inflammatory or otherwise, of the parts around them, except the partial absorption mentioned above, which very likely is an absorption merely of the watery parts of the clot; so that the cure by laminated fibrin, when once complete, may be expected also to be permanent. In cases where, after apparent cure, the aneurism has reappeared sooner or later,† it is probable that either the clot was not complete, but allowed circulation to go on through its cavity, or that a portion of it was of the soft, not the laminated, variety.

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* Colles on Aneurismal Sacs, *Dublin Quarterly Journ.* 1856, vol. xxi. p. 53; Wardrop, article "Aneurism," in Costello's *Cyclopædia of Surgery.*

As to the statistics of aneurism as it affects the different arteries in the body, I do not believe we are in a position to make any statements worthy of credit. In Dr. Crisp's work may be found an elaborate table of all the cases published up to that date; and Dr. Sibson has since given still more extensive researches as to aneurism of the aorta. But such tables, though of great interest and utility in some other respects,‡ are useless for the purpose of showing the liability of individual arteries to disease, since they always include an unnatural proportion of 'interesting' cases. Thus in Dr. Crisp's table of 551 cases, the popliteal aneurisms (137) are nearly as numerous as those of the thoracic aorta (175); and adding femoral (66) to the former, the proportion of surgical aneurisms in the lower extremity would be greater than thoracic,—an absurd conclusion. The only way to determine the relative frequency, with any approach to correctness, would be to take the unpublished and miscellaneous records of our large institutions, such as our hospital registers; and even this would not be absolutely correct, since, after all, it would only give the proportion among the working-classes. The point is perhaps hardly worth the trouble necessary to decide it.

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* Op. cit. pp. 127 sq.

† Sometimes after many months of apparent inaction.

‡ Principally in reference to the usual course and termination of each class of cases.

Spontaneous Cure of Aneurism.

Since aneurism is a disease which consists essentially in disturbance of the natural equilibrium between the force of the circulation and the elastic reaction of the arterial walls at the part affected, and since the blood which fills the aneurismal sac shows a strong tendency to coagulate when the full force of the circulation is diminished, it follows that the disease is one peculiarly easy of cure in favourable cases; for the coagula formed by the external layers of blood in contact with the wall of the sac soon acquire an organic connexion with it, and thus strengthen it, and, if uniformly deposited, enable it to resist the impulse of the blood over its whole circumference, and thus to check the further progress of the disease. When this has been once effected, *i. e.* when the whole wall of the sac has once recovered its power of resisting the distending force of the circulation, coagulation will generally advance from without inwards until the whole sac is filled with solid fibrin. The process may of course be interrupted by any thing which temporarily augments the force of the circulation, such as intemperance, disease, exertion, or perhaps even great mental agitation; or it may be retarded or suspended by internal causes which modify the coagulability of the blood.

Several conditions or modes of spontaneous cure have been pointed out by pathologists. 1. The most simple, and as it seems the most common, is the coagulation of the blood in the sac in consequence of mere retardation of the circulation. 2. Another cause of coagulation in the sac, much insisted on by writers, but rarely if ever seen in nature, is the pressure of the aneurismal tumour upon the artery in the neighbourhood of the sac, whereby the entrance of blood into the aneurism is hindered. 3. Another method, which has often been proved by dissection, is the stoppage of circulation through the tumour by a piece of clot which has been washed into the mouth of the vessel as it leaves the aneurism, or even at some distance from the latter. This plugs the opening incompletely at first (at least in most cases), but increases gradually by deposition of fresh fibrin, till the orifice is quite closed. The circulation is then diverted into the collateral arteries. 4. In some much rarer cases, a clot may be carried down into the artery above the tumour from an aneurism higher up, or the retardation caused by the latter may cause coagulation in the lower sac. 5. Another method of spontaneous cure is by suppuration and sloughing of the tumour; and it is believed that aneurisms may be cured by inflammation of the sac without suppuration.

The fact that few aneurisms are found without some formation of laminated clot upon, at any rate, a part of their circumference, shows how strong is the tendency to cure. Wherever the wall of the tumour is sufficiently strong, clot will form upon it during any temporary diminution of the force of the circulation; and this clot will encroach upon the cavity, and may form the nucleus for a complete cure. Unfortunately it usually happens, and especially in aneurisms situated near the heart, that this effort is only transient. Either the circulation, recurring with greater force, overcomes altogether the barrier set up against it, and reproduces the uniform expansion of the sac, or the sac has some weak point where the clot does not form, or the circulation in the centre of the tumour is too powerful for coagulation to go on there. The form of the tumour, and the nature and size of its orifice of communication with the artery, must of necessity exercise great influence on the probability of this event. Thus a tumour formed by a mere expansion of the artery (fusiform dilatation) will have a much more powerful stream passing through it than one which stands out from the vessel like a bud, and is attached to it by a kind of neck.* Tumours of the latter form are, it is true, comparatively rare; but the intermediate form, in which the dilatation is confined to only a part, and that not a very large part, of the circumference of the artery, are the most common—at least among surgical aneurisms—and are much more prone to spontaneous cure than the fusiform aneurism. Then the state of the mouth of the sac will exercise an effect on the stream. If the orifice be smooth, and the internal coat prolonged into the sac and free from deposit, the blood finds no obstacle to its passage; but in contrary conditions, with a rough orifice and coagula projecting into the artery, the force of the blood must be much broken.

The statement that aneurism is a mechanical lesion, and that its cure is to be sought by mechanical means chiefly, is not meant to exclude from consideration the advantage that may be derived from an increase in the relative quantity and coagulability of the fibrin of the blood. It is true that the attempts which have been made to induce coagulation directly by chemical means have as yet partially failed; but methods, such as bleeding and starvation, which increase the relative quantity of fibrin,* and diminish the force of the circulation, have often succeeded by themselves, and, when not pushed beyond what is prudent, form an important adjunct to some other plans of treatment.

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* But though the stream is more powerful, its lateral expansion, *i. e.* the pressure on the wall of the sac, is much less so. Hence the fusiform dilatation rarely attains the size of the saccular aneurism, and is not prone to bursting.

The student may now be asked to consider briefly each of the conditions or proximate causes of spontaneous cure spoken of above. The first is the mere retardation of the circulation. This may take place under conditions which it is impossible to foresee and therefore to produce; but the chief and happily always accessible requisite is *rest*, which has been frequently known to effect the cure of aneurism, whether external or internal, with little assistance from any other means. Such an instance is the following: A man was admitted into hospital, under the care of Mr. Luke, on account of a tubular aneurism of the femoral artery, unaccompanied by bruit or affection of the pulse in the lower part of the limb. The tumour was of a year's standing; it was compressible, and could be emptied of its contents. A plaster and bandage was applied, but apparently not so firmly as to produce much pressure, and he was put to bed. A good deal of pain was felt under the plaster for half an hour. It was left on for five days, and at the end of that time the tumour was found solid, and pulsation had ceased in it and in all the arteries of the limb. At the last recorded examination of the patient, two months afterwards, the pulse in the limb had not reappeared.† A great number of such cases might be cited from the various authors who have treated this subject. Hence the first advice given by a medical man to a patient in whom he discovers the existence of aneurism is to keep quiet. It is a pity that this recommendation is not made more stringent. The patient, instead of being merely enjoined to lead a quiet life and avoid all causes of excitement, should be rigidly confined to bed and to the recumbent position. But a still more powerful remedy consists in spare diet, though this should never be used except as an auxiliary to rest. The following case deserves notice as illustrating the possibility of cure even in a condition usually regarded as quite hopeless.* A publican consulted Mr. Stanley, in Oct. 1847, for a large pulsating tumour in the right breast, which *was rapidly increasing.* The symptoms do not concern us here; it was diagnosed to be aneurism; and he was advised to go home and keep himself perfectly quiet. Accordingly he went home, lay in bed for six months, and fed only on beef-tea, milk, and light pudding. At first the tumour seemed to grow; but from Christmas of that year its walls gradually got harder, the pulsation diminished in force, and by March 1848 were no longer perceptible externally. He then left his bed, having become by this time very pale, emaciated, and feeble. He lived very abstemiously for four years and a half, when a general election "excited him to deviate from the tranquil and abstemious habits he practised." He died of acute pleurisy after exposure. A large sac was found communicating with the aorta by an opening (1 in. by 1½ in.) just below the innominate artery in the posterior wall of the vessel. There was only a cavity large enough to contain a horse-chestnut, the rest was all filled with firm coagulum. The tumour had been of enormous size (7½ in. from side to side and 4 in. vertically). The disease which proved fatal appears to have been quite unconnected with the aneurism.

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* On the influence of bleeding and starvation on the amount of fibrin, see Todd and Bowman, *Phys.* vol. ii. pp. 311, 312.

† Luke, in *Lond. Med. Gaz.*, May 1845. For other cases see Bellingham *on Aneurism*, p. 148.

Bleeding is also a powerful agent in this plan of treatment. It is a remedy now little used, in consequence of its abuse in the time of our fathers; but it may be permitted to us to doubt whether the reaction has not been carried somewhat too far. Doubtless the repeated and copious venesections of old times could hardly be otherwise than injurious. Valsalva, it is said, used to bleed his patients day after day till they were unable to stand, and could hardly raise their arms from the bed.† This is an excess to which our modern habits, as well as the prejudices of our patients, would effectually prevent Surgeons of the present day from resorting; and there can be no question of the danger and impropriety of bleeding, when so insisted upon.‡ But the moderate use of venesection appears both rational and, as far as we can judge from recorded cases, successful. Bleeding seems to increase the relative amount of fibrin in the blood; nor does it appear, when moderately used, to lessen its coagulability; while its effect on the power of the heart and the rate of the circulation may be calculated with some approach to certainty. That this effect is transient is very true, but so is the action of all the cures for aneurism. A transient effect on the circulation is all that is needed for the formation of laminated clot, which will then, in favourable circumstances, go on to extend itself. Besides, bleeding has the recommendation that it can be repeated, and its quantity proportioned exactly to the condition of the circulation. The great objection to its use appears to be, that (in internal aneurisms especially, but in all aneurisms to some extent) the antagonism between the heart and the forces acting in the tumour has a tendency to cause the stoppage of the heart, and death from syncope.* This is especially likely to happen in the fluttering action which succeeds copious venesection, and it is on this account mainly that bleeding is dangerous. Still there are too many records by different, and those the most competent, observers, to allow of doubt as to its great utility in some cases, although probably in this, as in so many other things, the acute judgment of Dr. Watson has hit the mark when he says that venesection is only admissible so far as to reduce *excessive* arterial action. For this purpose it is certainly a more manageable and more certain agent than digitalis. Dr. Stokes has suggested a modification of Valsalva's treatment, in which the small and repeated bleedings which Valsalva prescribed are retained; but the diet is opposite to Valsalva's. "It should," says Mr. Porter, to whom we owe our knowledge of this suggestion, "be light and very nutritive, but of course free from any material

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* *Path. Soc. Trans.* vol. v. p. 107.

† Hodgson, op. cit. p. 145. Some writers have thought that the usual representations of Valsalva's practice are exaggerated; but it is clear, from Albertini's account (*Acta Acad. Bonon.* vol. i.), that its general principle is correctly understood.

‡ M. Broca seems favourable to the application of the method of Valsalva in the treatment of aneurisms of the thoracic and abdominal aorta, and of the subclavian artery. I do not observe, however, that he has given any instances of the application, successful or otherwise, of this method,

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except one, the reference to which I have been unable to verify; nor have I met with any instance of the application of Valsalva's method, properly so called, in modern practice. In a case brought before the Pathological Society, by Drs. Sibson and Broadbent, at one of their recent meetings, dyspnœa, the result of an aneurism of the aorta, had been much relieved by bleedings practised at rare intervals; but this is of course quite a different thing from Valsalva's treatment. Porter speaks of having bled to syncope, several times, a patient with aortic aneurism, and always with marked relief: op. cit. p. 82. In Mr. Hodgson's work numerous cases will be found quoted, where a practice more or less closely resembling that which goes by the name of Valsalva was followed with success.

* "An apprehension has been entertained by some, that a patient suddenly reduced to a state of syncope might never rally, and actually die of, or be killed by, the operation; and perhaps such a casualty may have occurred." Porter *on Aneurism*, p. 83.

of a stimulating nature." (Op. cit. p. 81.) It does not appear that any marked success has attended this plan.

The medical means available for the cure of aneurism, beyond those just enumerated, are very few. Certain drugs which retard the circulation have been used for this purpose; but without much success. Digitalis is both dangerous and uncertain. The action of tartar emetic, or of copious watery purges, seems only to be to produce weakness, which can be done with less distress by the means above enumerated. Acetate of lead does not seem to have had sufficient success to bring it much into notice. Some of the alkaloids exert a remarkable influence on the heart's action; such are aconite and veratrum.* Whether these have ever been used in internal aneurism I am not aware, but it would seem worth while to give them a cautious trial. M. Bouillaud has published a clinical lecture lately† on the Treatment of Aneurism by Iodide of Potassium. Four cases in all are mentioned. In one of these (a woman with aneurism of the carotid) a cure is claimed; and in the other three more or less benefit is said to have been obtained. In the case said to have been cured, the iodide was administered at first in the dose of a gramme ($15\frac{1}{2}$ grains) daily; and then the dose was raised to two grammes daily, which she took for two months. Gallic and tannic acids have been recommended; but our experience of these, as of other medicines, is chiefly negative. In fact, when aneurism is beyond operative interference,‡ the best thing that can be done appears to be to keep the patient quiet in bed for months, and years if need be, avoiding all causes of excitement, mental and bodily; to administer a light, unstimulating diet, but without denying him sufficient nutriment; to keep the part in such a position as may rather impede the supply and favour the return of blood; to use venesection in small quantities, and carefully, when the circulation appears at all above the normal standard, which, it should be remembered, ought to be below that of health; and, finally, to surround him with an equable cool temperature. By these means some very gratifying cures have been wrought; and although, perhaps, they will not be many, yet some lives will be spared by their rigorous enforcement, which would be sacrificed were the opinion acted upon that the disease is a necessarily fatal one, for which art can do nothing.

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* On the action of veratrum see *Lancet*, vol. i. 1862, p. 21.

† See *Brit. and For. Med.-Chir. Rev.* Jan. 1860.

‡ It is possible that an aneurism, though beyond operative interference, may still be accessible to local applications (*e.g.* at the root of the neck, or in the chest); in such a case, ice may be applied to the tumour. Some Surgeons use refrigeration, as an accessory to pressure, in the case of external aneurism. The method is one of doubtful efficacy. I have seen it tried occasionally, but without any effect. It should not be forgotten, that gangrene of the skin has been so produced. Vide Broca, op. cit. pp. 249 et sqq.

The second method of spontaneous cure, above indicated (p. 362), is that in which the artery is presumed to be obliterated above the sac by the direct compression which is exercised upon it by the aneurism. It is thought that a tumour, arising by a narrow neck from the artery, may fall back, as it were, upon the latter and close the vessel. This conclusion is drawn from dissection of cases principally of popliteal aneurisms, which have advanced to a large size, and have then become obliterated by clot. It may be remarked that, from the very nature of the case, such dissections must always be subject to much doubt; inasmuch as, at the period of the dissection, coagulation has advanced to such an extent that it is hardly possible to tell where it began; and that appearances nearly, if not quite, identical are found in tumours where it is clear that no such pressure could have been exercised; and further, that the explanation arose from those false views of the pathology of arteries which led Surgeons, a few years ago, to regard inflammation of their internal coat as a common result of pressure,* and obliteration of the artery thereby, as a common, if not a necessary condition of the cure of an aneurism by pressure.† So it was thought that the pressure of a large tumour would so irritate the artery as to make it inflame and become filled with clot, and that thus the aneurism would be cured. We know at the present day, after so many limbs have been dissected in which pressure has been used, whether successfully or not, that an artery will bear, without the least visible alteration of its lining membrane or of its calibre, an amount of pressure many times greater than could be exercised by any tumour. We know also the ease with which arteries elude the gradually-increasing pressure of tumours; nor are dissections wanting in which arteries placed in the conditions supposed are found to be completely pervious. Such a preparation exists in St. George's Hospital museum. It exhibits an enormous popliteal aneurism, which seems to have undergone a process of spontaneous cure. Its size, however, was so great, that the pressure it produced on the veins occasioned gangrene. The man was admitted on this account, and the large solid tumour in the ham was thought to be malignant, and the limb was amputated. The case occurred many years ago. No further history is preserved. The artery, which has been raised by the tumour and stretched over it for several inches, is nevertheless quite pervious. It communicates with the aneurism by only a very small mouth; and, though the limb has been injected, hardly any of the injection has passed into the sac, so firmly is the mouth of the tumour sealed by clot. In this case, if ever, it might be expected that the artery would be obliterated; since the tumour, being of immense size, must have exercised great pressure, and the blood showed a strong disposition to coagulate. It may be, however, that this method of cure is only possible when the artery is caught between the tumour and the bone, as in the case of popliteal aneurism developed on the posterior face of the artery; but it is hardly conceivable that the tumour should ever exercise very vigorous pressure towards the bone in such a case, since it meets with so much less resistance in the other direction. For these reasons, the existence of this method of cure seems doubtful. It is, at any rate, a matter of little practical importance (though no doubt of much pathological interest), since no one would dream of encouraging the growth of a popliteal aneurism on the speculation of its ultimately curing itself by pressure on its own artery.

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* See Freer *on Aneurism*, p. 112; Hodgson, op. cit. p. 106.

† Most of the recorded cases are clearly instances of obliteration of arteries by impacted clot; as in the case quoted by Hodgson (op. cit. p. 110) from Astley Cooper, where the carotid artery was found obliterated in a case of aneurism of the aorta. This could hardly have been the result of pressure, since the effects of such pressure must have been more marked upon the trachea, pneumogastric nerve, or jugular vein than the artery, but is no more than what often occurs from impaction.

A more clearly proved mode of cure is that which is produced by the impaction, in the distal portion of the vessel, of a portion of clot from the aneurism. The occurrence of this circumstance in the arterial system in cases of fibrinous concretions on the valves of the heart, as pointed out by Dr. Kirkes, has now been universally admitted, and is a frequent cause of gangrene, of softening of the brain, &c. (see p. 333). It seems also to be a not infrequent cause of the obliteration of arteries below an aneurismal tumour, followed in some cases by gangrene of the limb (or by death if situated near the heart), in others by the spontaneous cure of the aneurism. The way in which this latter result is produced appears to be as follows: If a branch comes off from the artery between the aneurism and the part at which the clot is impacted, this branch may enlarge until it replaces the original artery, and the whole process may remain without result. But if no such branch comes off (as is the case in the great majority of instances, since the impaction usually occurs just as the artery leaves the aneurism), then the whole force of the heart, as far as it acts on the artery affected, is employed in dilating the sac, the artery above it, and the branches of the latter. Sometimes the sac yields to the force, and the aneurism bursts, especially under undue muscular exertion.* If this does not take place, and the circulation through the limb is still to go on, the branch or branches above the aneurism, and their communications or anastomoses with the artery below it, must enlarge. When this is effected to a sufficient extent, the full force of the circulation is withdrawn from the aneurism, which will then usually undergo the process of coagulation. It is quite obvious that it matters nothing to this process how far below the aneurism the clot may be impacted, provided that no considerable branch comes off in the interval, since the intermediate portion of artery exercises no influence on the circulation, and may, for the purpose of this argument, be regarded as part of the aneurismal sac. This process of spontaneous cure is imitated in the methods which bear the names of Brasdor and Fergusson.

This plugging process may go on gradually as well as suddenly, as is proved by its being found occasionally complete in persons who have never presented the serious symptoms known to accompany the impaction of a clot in a large artery; and still more clearly, by its being sometimes met with in an imperfect condition, the artery being lined with a tube of fibrin, which still leaves a small channel for the blood.† It seems possible that the existence of another aneurism higher up may sometimes effect the spontaneous cure of the lower one, either in consequence of clot being washed down from the upper aneurism into the lower, or into the artery as it enters or leaves the lower sac, or (as it is said) by the retardation of the current caused by the upper aneurism. It is difficult to be certain as to whether the latter mode of cure ever really occurs, though cases are on record which appear to prove the occasional occurrence of what is, at any rate, possible, since feebleness of pulse in the limb below is a constant symptom of aneurism. In the other case, *i. e.* when a piece of clot is washed out of an aneurism above, the process exactly resembles that which has just been described.

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* Such seems to be the true explanation of a case reported by Mr. Avery, in *Path. Soc. Trans.* vol. iii. p. 88, as an instance of pressure by the aneurism on the artery above it.

† See above, *Atheroma*, p. 328.

There remains another process by which aneurisms have been known to become cured; and this consists in the suppuration of the sac and the ejection of the whole tumour by a process of sloughing. In this process, as in other instances of sloughing, the artery, for some distance on either side of the gangrenous part, is closed by coagulum,* so that hæmorrhage does not take place, as might have been apprehended.† Or, in other cases, the sac may slough, and the artery, not being thus sealed, may give way, and the patient survive the hæmorrhage thus occasioned; syncope is produced, and coagulation occurs during this syncope, sealing the mouth of the artery. This, at least, is Dr. Crisp's opinion, but it is doubted by Broca; nor do I find references in Dr. Crisp's work to the cases upon which such an opinion is founded. Inflammation without suppuration, in the neighbourhood of the sac, is also spoken of by Broca and others as an occasional cause of spontaneous cure. I have not been able to find any cases which are, to my mind, quite satisfactory. Some, as the case reported by Mr. Sidey,‡ appear to have been cures by impaction of clot.

The surgical treatment of aneurism, as far as it is successful and rational, is merely an artificial imitation of these processes. The treatment most in use in the present day, that by compression of the artery above the tumour, has no other aim than to imitate nature in the first of the processes described above, so as to slacken the circulation through the aneurism and allow the blood in it an opportunity of coagulation. The Hunterian operation has essentially the same object, although it accomplishes it in a somewhat different way, and by obliterating a portion of the artery above the tumour puts a more decided, but at the same time more temporary, check on the current of blood. The cure by flexion (Mr. Hart's method) aims at combining this first process with the second, in which the aneurism is compressed by the parts around it, and itself (perhaps) compresses the vessel. Mr. Fergusson's plan of manipulation, or crushing, is derived from observation of cases in which the natural cure was effected, or attempted, by the impaction of a clot in the artery leaving the sac. Brasdor's method, so far as it is justifiable at all in practice, *i. e.* with the modifications hereafter to be described, is identical with this in its object, and rests upon the same pathological basis. Direct pressure appears to cure aneurism usually by displacing portions of the clot, and may perhaps sometimes act by setting up inflammation in the sac or parts around it, which leads to coagulation. Finally, the old method, by opening the sac and tying both ends of the artery, bears the strongest analogy to the cure by suppuration, and is, in fact, a kind of excision of the tumour.

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* See MORTIFICATION, vol. i. p. 179.

† See the cases related by Hodgson, op. cit. pp. 103-5.

‡ *Edin. Med. Journ.* vol. iv. p. 768.

The methods of spontaneous cure have been dwelt upon at this length with the view of impressing upon the mind of the reader that all successful plans of treatment are successful from being imitations (whether designed or fortuitous) of these natural processes, in the hope that this fact may lead practitioners to a more careful study of the workings of nature in this particular, and the conditions under which she works. Such a study, carried on by various observers, could hardly fail to be fruitful in results which would lead to the preservation of numerous lives that would be sacrificed to the idea that internal aneurism is a disease almost necessarily fatal. What else is it than the careful study of the natural process of cure that led Hunter to his brilliant and daring proposal of tying the artery away from the seat of the disease? What else led the Irish Surgeons to see that compression, in order to imitate nature, need not suspend the circulation entirely, need not even act continuously; and thus to substitute for the intolerable torture inflicted by the old plan of compression a treatment which in ordinary cases is harmless, and in a few absolutely painless? Let us remember how comparatively short a time it is since one of the most celebrated Surgeons of his time* announced his preference for amputation over all other methods of treating popliteal aneurism. Let us not forget that one of our most justly valued living authors on this subject† was so satisfied with the advance which had been made at the time he was then writing, as to express his opinion that "the improvements that have been effected in the mode of applying the ligature to arteries have brought the surgical treatment of aneurism to a degree of perfection which leaves but little room for advancement." Nor was such an appreciation of modern Surgery at all exaggerated or unreasonable to those who looked at it, as Mr. Hodgson did, by comparison with the mortality after the old operation. In our time Surgery has made such rapid advances, that the mortality, which under the system praised by Mr. Hodgson must have amounted to a large percentage of those operated on,‡ is now very much reduced by the invention of instrumental compression, and even this will no doubt soon be further reduced by the more frequent use of flexion and digital pressure. So it may be in medical practice. At the present day, it is hardly too much to say that a patient with internal aneurism is condemned to death as certainly as one with external aneurism used to be to amputation. A century hence, we may hope, our descendants will have as solid reason to boast of their improvement upon the science of Watson and Latham as we have to congratulate ourselves on our advance upon the doctrines of Pott.

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* Pott, *Chirurg. Works*, vol. iii. p. 220.

† Hodgson, op. cit. p. 190.

‡ I am aware that in Dr. Crisp's tables the mortality of 110 cases of

The extent to which the deposit of clot in spontaneously cured aneurisms proceeds, is one of the most curious and beautiful instances of that power of adaptation which the many processes of disease in the body furnish in such abundance to our notice. Generally speaking, the fact of the completion of this deposit implies the entire obliteration of the aneurism and of the artery for some distance on either side of it; and so great are the resources of the collateral circulation, that any part of the arterial tube beyond the first three great branches of the aorta may be, and has been, obliterated without compromising the life of the patient. Thus, numerous cases of obliteration of the thoracic aorta below this point have been recorded; the innominate artery has often been successfully obliterated by nature, though never as yet by art, and a case is even on record* in which the cœliac artery and all its branches, with the commencement of the superior mesenteric, were involved in the obliteration of an aneurism seated on the abdominal aorta, without any loss of vitality of the viscera, which must (although the fact is not stated) have been nourished from the phrenic arteries on the one hand, and the inferior mesenteric on the other.

But these great channels of vital supply, though in favourable cases they may be stopped in this gradual manner without loss of life, cannot be so without extreme danger. In rare instances, how-

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popliteal aneurism operated on by Hunter's method is given at 12 only, and in 7 of the others amputation was necessary, and succeeded. But there is much danger in drawing conclusions from lists formed of published cases, which usually (perhaps it may be said always) include far too large a proportion of successful operations. From the comparatively few cases I have myself witnessed, I should suppose that the mortality is nearly double that which Dr. Crisp's table gives. But such questions can never be settled till our large hospitals can be persuaded to make efficient arrangements for the preservation of complete and unbiassed statistics. A very different computation of the mortality will be found further on.

* Hodgson, op. cit. p. 125.

ever, we see that the cure of the aneurism proceeds to such an extent as to insure the sac against the force of the circulation, but that a channel is still left by which the blood passes, as it used to do through the healthy artery. Of this a striking instance is figured in Mr. Hodgson's work[*]—a tubular aneurism of the femoral artery which has been coated throughout with a thick layer of laminated fibrin, while a channel is left in the centre, through which the circulation has been carried on, just as if through the natural artery.

Another case of this species of cure was exhibited by the present writer to the Pathological Society, and may be found described in their *Transactions*, vol. ix. p. 172. The preparation in St. George's Hospital museum displays an aneurism of the cœliac axis, of which no complaint was made and no symptoms existed while the patient was under observation during life. It has been so far filled with laminated coagulum that the walls of the sac are every where of great thickness, and there is only a small portion in the centre in which the clot was loose and soft, filling it only partially, and no doubt formed after death. The three branches of the cœliac axis spring from the distal extremity of the aneurism, and are in all respects natural. There could be no doubt that circulation had gone on through the central part of the sac, which had thus replaced the original artery.[†]

Symptoms of spontaneous cure. The symptoms of the occurrence of spontaneous cure in an aneurism appear to vary according as the cure is produced by the gradual deposition of laminated fibrin in the sac or artery, or is the consequence of sudden occlusion of the artery by clot. When it occurs by sloughing of the sac, the progress of the disease is of course entirely different. Usually nothing is remarked except that the pulsation becomes less violent, the tumour less prominent, and the sac, when emptied by pressure on the vessel above, more solid and resisting. Soon afterwards, in a time varying according to their size and position, the anastomosing branches will be felt enlarging, in most cases of superficial aneurism. When this is the case, the cure is generally not far off. The aneurism will soon be found transformed into a solid tumour of much less than its original bulk.

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[*] Plates to Hodgson, op. cit. pl. vii. fig. 4.

[†] See also Sir Astley Cooper's case related by Hodgson, op. cit. p. 134, and preparations from two cases in the Hunterian Museum, nos. 1641, 1687, 1688. The latter two preparations are a pair; they show aneurisms of the internal carotid on either side nearly filled with laminated clot. The history of the case extends over five years, and is reported by Sir G. Blane. The symptoms were all cerebral: dimness of vision, diplopia, loss of appetite, maniacal excitement, &c. Benefit was always derived from bleeding, antimony, and abstinence.

Sometimes things go on differently; the cure being ushered in by symptoms of great severity, principally disturbance of the functions of parts supplied by the affected vessel, accompanied by more or less pain, sometimes very severe. Thus in a case of spontaneous cure of aneurism of the innominate artery, reported by Dr. J. W. Ogle,* the cure was ushered in by urgent head-symptoms, and complete unconsciousness. The carotid artery was found after death to have been obliterated; and, no doubt, the head-symptoms coincided with and were caused by the impaction of a clot in the vessel supplying the brain. In a case of aneurism of the right carotid, involving, perhaps, also the root of the innominate, treated by Wardrop's method, and reported in his work on *Aneurism*, p. 98, may be seen the account of a similar seizure. "The patient was taken suddenly worse, and appeared to be dying; his countenance ghastly, and covered with perspiration; tracheal rattle, and inability to swallow." Other severe symptoms were also present. He remained in this state for several hours, and then rallied. At the same time, it was noticed that the arteries of the right arm and forearm, which up to that time had pulsated more strongly than those of the left, had become pulseless. The only probable explanation of this train of symptoms is, that a portion of the clot in the sac had fallen into the subclavian artery, and closed it. The arm was partly paralysed for some time; but ultimately the anastomosing vessels enlarged, and the patient was in all respects cured.

This process of cure by impaction seems generally to occupy a period of at least several hours; but whilst these sheets are passing through the press I have become acquainted with an instance of the spontaneous cure of aneurism, in all probability by impaction of clot, which deserves notice on account of the extreme suddenness of the cessation of the symptoms. A man was under the care of Mr. De Morgan at the Middlesex Hospital for popliteal aneurism, which was treated by compression of the femoral artery. This gave him so much pain that he was with difficulty induced to keep the instrument on, and Mr. De Morgan, at his urgent request, was about to tie the artery. The House-Surgeon was sent for in the afternoon, as the man was complaining of so much pain, that he insisted on taking off the instrument. The tumour was then seen to be beating violently. The pressure was removed. *Twenty minutes* afterwards, when he was again seen, all pulsation had ceased, and it did not recur. The tumour, which had been very tense and painful before, became softer; and in twenty-four hours the circumference of the knee diminished one inch. The pain and extreme tenderness subsided at once upon the arrest of the pulsation.*

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* *Path. Soc. Trans.* vol. ix. p. 167.

The process of spontaneous cure may be, and very often *is*, interrupted. A portion of the sac becomes strengthened by the deposition of clot; but where the circulation is more active, the sac goes on expanding, and either bursts, or causes death by pressure on neighbouring parts. Often, too, the clot, once formed, is broken down by the force of the stream; or it has been known to be dissected off from the wall of the aneurism, and has been found inverted by the force of the current, so that the convex portion of the clot, which had been moulded to the wall of the tumour, was found turned towards its centre. Of this, the following case is a remarkable instance. In the *Path. Trans.* vol. iii. p. 46, 1850-51, is an account by Dr. H. Roe of a case of aneurism of the anterior cerebral artery, which proved fatal, apparently from increase of size and gradually advancing pressure on the brain. The tumour was of the size of a hen's egg, and consisted of two parts; the upper (farthest from the vessel) being almost translucent, and filled with soft yellowish fibrin, imperfectly laminated; while the lower compartment, which directly communicated with the artery, was filled with coagulated red blood, like that in the vessel, and separated from the cavity on the upper surface by a dense laminated mass of fibrin. This mass had attained a considerable degree of organisation, containing, with blood-discs, very numerous fibres. The convexities of the laminæ were towards the artery and its special compartment of the cavity, or *vice versâ* their *concavities* corresponded with the upper part of the tumour. Dr. Brinton, in a report on this specimen, believes that this peculiar arrangement of the clot resulted from the dissection off the wall of the aneurism of the ordinary laminated clot by blood from the artery, and the subsequent inversion of that clot; in fact, an interruption of the process of spontaneous cure. In cases where the history can be followed, it usually is found that such interruptions correspond to, and are occasioned by, some unusual exertion or emotion of mind by which the circulation is unduly excited, or some accident in which, perhaps along with a similar affection of the circulation, the tumour may have been directly injured. Reference has been made above (p. 358) to a case in which the clot continued for a long time to grow without pulsation. In Mr. Prescott Hewett's account of that case, the reader will be struck by the fact, that the cure was not previously a sound one; that the pulsation recurred twice at long periods after the operation; and that, therefore, the clot was probably formed under the influence of a too powerful stream of blood, and so might be looser and less resisting than laminated fibrin usually is. Besides, the fact that the patient was far advanced in phthisis might have modified the coagulability of the blood. Many other cases are on record, in which clots, both after spontaneous and artificial cures, have softened and appeared to become absorbed; but cases in which they grow without pulsation are rare. Another example of this singular event will be found in the foot-note below.

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* In another case under Mr. De Morgan, at about the same time, in which the tumour was rapidly enlarging, although pressure was used to as great an extent as it could be borne, he had intended to tie the artery. On the morning of the proposed operation, however, the pulsation stopped, suddenly, according to the patient's account, and it remained absent for about ten hours, and then returned, but not with the same violence. The case ultimately did well under pressure.

After the cure of aneurism is completed, *i. e.* after the whole cavity is filled with laminated clot, no further change takes place in the swelling except a decrease in size, very perceptible at first, while the fibrin is in the process of contracting, and which proceeds slowly for a considerable time, until the clot has assumed its condition of greatest density, in which condition it may remain during the rest of the patient's life. By this gradual contraction of the clot, small aneurisms are reduced to a size imperceptible to external examination, and sometimes can hardly be recognised even by dissection. The collections which used to be described as "steatomatous or atheromatous tumours of arteries" were probably small cured aneurisms. But in swellings of larger size the laminæ of the clot remain distinct, though usually decolorised, during an indefinite period. Other changes, however, sometimes take place in aneurisms which appeared to be permanently cured. These, probably, depend on the imperfect or loose formation of the clot; though later on, the wall of the tumour takes part in the action. Thus the clot may be found softened and changed into a grumous material;* or suppuration may take place, perhaps, from the irritation of this decomposing fibrin, and the whole mass be ejected. This took place in a case operated on by Mr. Lawrence, a year after the apparent cure of the disease.* Finally, the clot has been found more or less mixed with cretaceous matter.

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* In a case reported by Freer, *Obs. on Aneurism*, p. 106, and quoted by

SYMPTOMS AND DIAGNOSIS OF ANEURISM.

The symptoms of aneurism may be easily inferred from its definition. A tumour containing blood and communicating with an artery will, in all ordinary circumstances, receive pulsation from the artery; it will be situated on the course of the vessel, and will be incapable of being removed from it; it will (so long as part of its contents are fluid) diminish in size when the circulation through the vessel is stopped by pressure on the artery above, while, on the contrary, some increase in size may be sometimes observed when pressure is made below the tumour; and, after the circulation has been stopped and the tumour emptied as far as possible, it may be seen to fill again gradually, and in a certain definite number of beats of the pulse, when the pressure is withdrawn. Besides these symptoms, which may be observed in every case of external or surgical aneurism, the two following must be borne in mind, which, though not always to be found, are so constantly present as to make them of great value in diagnosis. First, that the pressure of the tumour, and the diverticulum which it forms for the arterial current, will usually cause a diminution in the force of the pulse on the affected as compared with the unaffected side; and secondly, that the pulsation is usually accompanied by a peculiar rough blowing sound, called the aneurismal bruit. The assemblage of these symptoms furnishes as decisive evidence of the nature of the disease as it is possible to have of any thing not actually under our eyes; and as it is rare for those which are most characteristic to be absent in external aneurism, the diagnosis does not generally present any great difficulty. In internal aneurism,

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Broca, a very large aneurism had been rapidly obliterated by pressure, but had never much diminished in volume. *Twenty-two years* afterwards, the tumour having grown during the interval to an enormous size, but without pulsation, it burst, and a mass of brown grumous material was discharged. The patient died, worn out by fever and suppuration. It may be noticed, that in these cases where the clot afterwards softens, it is usually remarked at the time that the aneurism does not diminish much in size after its apparent cure. This then is to be regarded always as a suspicious circumstance.

* *Med.-Chir. Trans.* vol. vi. p. 204.

i. e. aneurism seated in the chest or abdomen, it is very different; the tumour is often imperceptible, or if perceptible by percussion, or even by palpation, yet the course of the vessels is so far from the surface, and the tumour may extend so widely, that it is impossible to be sure that the tumour corresponds exactly to the position of an artery. The pulsation is frequently imperceptible, or may be derived from the near proximity of the heart or great vessels, without any real connexion with them,—a frequent cause of error in the diagnosis of tumours, especially in the abdomen. It is impossible to stop the circulation above, and watch the tumour refilling; the inequality of the pulse on the two sides, though very useful as a corroborative symptom, may be produced by a great variety of other causes, and the aneurismal bruit is very frequently absent. Hence, while the Surgeon can usually pronounce a perfectly clear and unhesitating opinion as to the existence of aneurism in the limbs, the Physician is beset with so many difficulties, that although they in general pay more attention to diagnosis, and therefore may be presumed to excel more in that branch of our art, the ingenuity of Physicians has not succeeded as yet in pointing out any unmistakable signs of internal aneurism; and in many cases, even where the strongest reason exists for suspecting its presence, it is impossible to come to a certain conclusion during the lifetime of the patient.

It is worth while to study the above-mentioned general symptoms of aneurism a little more in detail, particularly with reference to their bearing upon diagnosis. The diseases with which aneurism may be confounded are, tumours, or abscesses, lying upon the course of large arteries, and malignant tumours of bone, which sometimes pulsate from the development of large blood-cells in them; further, it is necessary to distinguish between aneurism and a mere enlarged and relaxed condition of the artery, in which pulsation is much more perceptible than usual. In the first place, then, an aneurism is a tumour contained in a cyst, or sac; it is therefore separable from other parts, which latter, if no inflammation has taken place, can usually be felt to glide upon it, and is more or less movable according to the depth of its connexions and to the extent of its base. Next, as to the nature of its contents. These are, perhaps, more commonly a mixture of clot and fluid than merely fluid blood, and it is rare, therefore, to find pulsation equally perceptible in every part of the tumour. The character of the pulsation, it must be remembered, depends on two things; on the nature of the contents, and on the condition of the orifice. The usual character of the pulsation of an aneurism is that of a wave, gradually swelling up and gradually subsiding. There is usually superadded to this general heaving, when the artery lies between the sac and the hand of the observer, a distinct line of more rapid and thrilling pulsation, which marks the course of the vessel. This may generally be observed very plainly in popliteal aneurisms which are growing towards the knee-joint, and have the artery crossing them. The heaving character of the pulsation in aneurism differs from the more rapid and simultaneous pulsation of all its parts in a vascular tumour, which pulsates from the presence of a number of large vessels, and in which, therefore, the movement commences at all parts of the tumour, instead of being propagated from one. It differs equally from the movement communicated to a tumour by a large vessel lying beneath it, which is simply a rise and fall. The extent and power of the pulsation in an aneurism depend usually upon the amount of clot in the sac; and thus the gradual decrease of pulsation may be watched from day to day, as an aneurism is becoming consolidated under the use of pressure. Pulsation may be obstructed by clots lying about the mouth of the aneurism, and sometimes may be altogether absent, apparently from the same cause, although the sac still contains fluid blood. These are the most difficult cases in respect of diagnosis, which is then inferential merely, and almost as obscure as in internal aneurism. Sometimes the pulsation may even have disappeared, in consequence of the tumour having been spontaneously cured, and yet its size and interference with the functions of the limb may cause the patient to apply for advice to a Surgeon who has not seen it during its earlier stages. In such a case as this, the patient's account of the previous symptoms, if he be a person of intelligence, will be of great value; while, if he can give no account of the disease, the diagnosis will probably be uncertain. Such was the case in the patient mentioned on p. 369.

The pulsation can be made to cease at once by pressure on the artery above the tumour,—a character common, of course, to all tumours which derive their pulsation from the vessel, whether by continuity with it or not; whether aneurisms, enlarged glands, abscesses, or any thing else pressing on the artery. Pulsation in an aneurism is always more powerful than in the arteries leading to it, while the sac contains much fluid. This is a consequence of the powerful reaction between the wave of fluid and the walls of the sac (see p. 355).

The gradual return of the tumour to its full size, after it has been emptied by pressure, the circulation having been stopped, is another feature very characteristic of aneurism; and it is important to note the variations in this respect, which will be observed in an aneurism as it is gradually filling with clot. The more fluid the sac contains, the more completely will it be emptied, and the more readily will it fill. As the deposit of clot proceeds, the beat becomes less forcible, and the tumour varies less in size on pressure upon the artery. It should not be forgotten, that since pulsation is caused by the reaction which the parts around exercise against the impulse of the heart, it depends for its perfection upon the integrity of the sac; hence it is frequently not present at all when there is no sac, as in rupture of an artery before a sac has formed. Thus, in a case where the patient had been caught by some machinery in motion, and the leg violently twisted, much ecchymosed blood was found in all parts of the limb below the popliteal space, but no pulsation ever appeared in this collection. The limb was amputated about a fortnight after the accident on account of gangrene, when the popliteal artery was found broken completely across. So in aneurisms which, after advancing rapidly, suddenly burst with a large rent, the pulsation often vanishes completely; to recur, perhaps (if the accident is not fatal), when the rent has healed.*

Having clearly before us the symptoms of surgical aneurism, the following rules may be laid down for its diagnosis from each of the affections above spoken of.

Diagnosis of aneurism from tumours pressing on the artery. The greater number of tumours which lie against an artery do not cause any bruit. If they do produce any sound, it is a mere dull short beat, or 'thud,' as it is sometimes called, and may in these cases usually be imitated by pressing the stethoscope firmly on any large superficial artery. On the contrary, the bruit of an aneurism is usually a somewhat prolonged rasping or blowing sound, and cannot be artificially produced in a healthy artery.

The pulsation communicated to a tumour lying over an artery is an equable rise and fall, which ceases entirely when the pulse is stopped, and recurs at the first renewed beat of the artery as strongly as ever. The pulsation of an aneurism is generally a wave of fluid, which, on the removal of pressure from the vessel, does not attain its greatest height till after a certain number of pulses, and which causes not merely a rise and fall of the tumour, but also an expansion in every direction. The surest diagnostic sign, however, is, that the tumour can be dragged away from the vessel, while the aneurism cannot; but this is not always the case, since the tumour may be too deep, or too tightly bound down by fascia, or too closely adherent to the artery, to be moved. To this it may be added, that if the swelling be an abscess, the symptoms of that affection will sometimes be present; but the occurrence of suppuration around, or in, aneurismal sacs must be kept in mind; so that too great stress should not be laid upon the symptoms of suppuration, as if they excluded the notion of aneurism; and in any case in which there is doubt whether the swelling is an abscess or an aneurism, auscultation should be carefully used, since the rough aneurismal sound will prove that, even if it be an abscess, the swelling communicates with the neighbouring artery.*

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* See also the case on p. 352.

Pulsation may, however, be caused by the tumour being, as it were, enclosed in arteries. This was the case in the patient in whom Mr. Moore tied the common iliac artery, on account of a pulsating tumour situated exactly in the position of an aneurism of the external iliac artery, and having "a rough and loud murmur." On dissection it was found that the tumour was formed by cancer deposited in a mass of glands situated in the bifurcation of the common iliac between the internal and external iliac arteries, closely bound down to those vessels, and particularly to the external iliac, by an envelope of fascia, having the obturator artery beneath it, and perforated by the gluteal, sciatic, and pudic arteries. In this case, though the question of aneurism or pulsatile malignant tumour was discussed, it was found impossible to establish the diagnosis of its cancerous nature; nor, after death, could any means of diagnosis be suggested, except that the urine in the bladder contained cancer-cells, which might perhaps have been found by microscopic examination. But as the only specimen of urine which had been seen was quite clear, it is possible that the cancer-cells might have been only occasionally present; and it must be allowed that no means of certainly diagnosing such cases are known at present, since, from its shape and depth, the tumour separated the fingers as it rose, so as to simulate the expansive pulsation of aneurism, and the sound was not appreciably different from what is found in many aneurisms. Even had the tumour been more superficial, it was so surrounded and penetrated by large arteries, that its pulsation could not have been stopped by drawing it away.*

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* Great caution is needed in dealing with tumours lying near large arteries. Broca (p. 427) relates that of the four successive senior Surgeons of Hôtel Dieu, Ferrand, Desault, Pelletan, and Dupuytren, the others each opened an aneurism by mistake for an abscess, and Pelletan laid open a malignant pulsatile tumour, intending to perform the old operation for aneurism.

Mr. South† mentions a case of varix of the internal jugular vein, preserved in the museum of St. Thomas's Hospital, which encircles the artery, filling nearly the whole side of the neck, and notices the difficulties which must arise in such cases in separating the pulsation of the tumour from that of the artery round which it is, as it were, folded. In the case of a varix, Mr. South thinks that it might be distinguished "by pressure of the swelling at its farthest extremity from the heart, in which case its size will diminish; whilst if pressure be made between it and the heart, its bulk must be increased, which is the very reverse to aneurism."‡

Diagnosis between aneurism and pulsatile tumours of bone. The diagnosis between pulsatile tumours of bone and aneurism is very difficult; so that some of our best Surgeons have been deceived by the resemblance. The diagnostic symptoms are the following, but they are seldom or never all present together: 1. The bruit seems but rarely as well marked in pulsatile tumours as in aneurism, and is often altogether absent. "It is true," however, as Mr. Stanley remarks,* "that in states of general anæmia, also in diseases of the aortic valves allowing of regurgitation, limited portions, or even the whole, of the arterial system, without organic change in the vessels, may impart to the stethoscope a murmur approximating to the bellows-sound of aneurism. And if, under such circumstances, a tumour should happen to form in any region of the body, so close to a large artery as to influence its pulsations, then, by the stethoscope, the bruit or bellows-sound may be recognised in the artery as forcibly as in an aneurism." 2. The pulsation is usually more sudden, less heaving, and less expansive in the pulsatile tumour, and is equally forcible over the same space of tumour, whether the latter be large or small; while in aneurism the bulk of the swelling and the force of its pulsation increase and decrease together. 3. The condition of the bone with which the tumour is connected will often aid in the diagnosis. Thus, in Mr. Stanley's case (*Med.-Chir. Trans.* vol. xxviii. p. 318), a plate of bone was found in the walls of the tumour. In another, which I saw at St. George's Hospital some years ago, where a pulsatile tumour of the ilium projected in the buttock at the situation of the sacrosciatic foramen, and closely resembled in many respects an aneurism of the gluteal artery, the diagnosis was correctly established by observing fulness in the iliac fossa, the ilium being expanded on both sides by the tumour developed in it.† When an aneurism, on the contrary, eats through a bone, it simply chisels out a hole in it; so that if the sac can be emptied and made to collapse, the edges of the hole will be felt. 4. These pulsatile tumours of bone appear to be always, and certainly are usually, cancerous; so that the general symptoms of the cancerous cachexia may be present, or some other cancerous tumour may be seen. In the pulsating tumour in the buttock just mentioned, the presence of hæmaturia at a later stage of the case revealed the existence of mischief about the kidney, which was found after death to depend on the deposition in that organ of a large mass of encephaloid cancer. It must be admitted, however, that the diagnosis between pulsatile tumour and aneurism is often a matter of the greatest difficulty, even if it be possible; and that the diagnosis of cases of aneurism unaccompanied by pulsation, such as those mentioned on pp. 358, 377, is sometimes impossible.

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* This was the fifth case in which the common iliac artery has been tied in London; and, out of these five, it was the third in which the disease was supposed to be of aneurismal, but proved to be of malignant, nature (*Med.-Chir. Trans.* vol. xxxv. p. 468). Recently a case occurred in Mr. Paget's practice, which still more strikingly illustrates the difficulties of diagnosis which beset pulsating tumours lying near the large arteries in the abdomen. A man was admitted for pulsating tumour in the groin and iliac fossa. Much doubt existed as to its nature. Most of those who saw it inclined to the opinion that it was aneurismal; others thought it malignant. It was decided to cut down on the external iliac, and if the tumour appeared to be an aneurism and ascended too high to allow of this vessel being secured, then to tie the common iliac. The operation was performed accordingly; but the false pelvis was found filled with a large mass, partly solid, and not pulsating, which so displaced the arteries that it would have been hardly possible to tie the common iliac. However, under the impression that the tumour was malignant, the attempt was not made. The tumour fungated out of the half-healed wound of the operation, and the man died of arterial hæmorrhage. It was then found that the tumour was really aneurismal, and partly consolidated. *Brit. Med. Journ.* 1858, p. 724.

† Chelius, vol. ii. p. 202.

‡ A case will be found in the *Med.-Chir. Trans.* vol. xxviii. p. 314, in which Mr. Earle tied the subclavian artery on account of a supposed axillary aneurism; which, however, turned out to be a tumour connected with the median nerve. It is to be regretted that nothing is said about the symptoms beyond the general statement, that "the tumour presented all the characters of aneurism."

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* *Med.-Chir. Trans.* vol. xxviii. p. 316.

† In Mr. Stanley's case also the tumour projected on both sides of the ilium.

Diagnosis between aneurism and aneurismal dilatation. The diagnosis between an aneurism and a mere dilatation is usually quite obvious, at least between extreme examples of the two. The dilatation is generally unaccompanied by any distinct tumour or by any aneurismal bruit. It contains no clot, and hence may be completely emptied by pressure on the artery above, filling at once when that pressure is removed; and there is usually no interference with the pulse in the arteries below the disease.

TREATMENT OF ANEURISM. THE OLD OPERATION.

The medical treatment of aneurism has been discussed sufficiently for the purposes of a work on Surgery. It now remains for us to consider the various plans of local treatment which are in use in ordinary or encysted aneurism, and to point out, as far as our present experience enables us to do so, to what extent and in what cases each plan is likely to prove useful.

The first method of treatment, usually called the old operation, or the method of Antyllus, aims at the entire eradication of the aneurismal tumour. The operation is thus performed: the artery above the seat of aneurism is to be commanded, if possible, by a tourniquet, or by the finger of an assistant; then an incision is to be made into the tumour, care having been taken to expose it by a sufficient dissection of the superficial parts, should these involve any important structures; the clots are then to be rapidly turned out of the sac, and the orifice by which it communicates with the artery is to be searched for; a ligature is then to be placed on the vessel above and below* the aneurism. The opening of the vessel can be found by passing a probe from the sac, first upwards and then downwards, in cases where a distinct sac is found; but in 'diffused' aneurism this is often impossible, according to Pelletan. When the ligatures have ulcerated through the vessel, and the cavity has been filled up by suppuration and granulation, the tumour is radically extirpated.

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* Keyslère, a Surgeon of Lorraine, but practising in Italy, and who appears to have reintroduced the method of Antyllus into Italy, used only one ligature above the tumour. Three of his cases are reported by Testa of Ferrara (who seems to have learnt the operation from him), of which two were successful. Mazotti, who had seen Keyslère operate, used two ligatures generally, but not always. Pelletan, *Clin. Chir.* vol. i. p. 142.

Such is the description, in general terms, of an operation which, thus stated, appears simple enough. Its difficulties, however, are often of the gravest character when the aneurism is deeply seated, when the artery communicates with its deepest part, and when the sac contains recesses or is closely united to the parts around. Besides its difficulty, it is often an extremely severe operation, requiring an incision of extraordinary length,* necessarily involving considerable hæmorrhage, and leaving an enormous cavity to fill up. The records of ancient Surgery show that it used to be often a tedious and desperate proceeding, which sometimes proved fatal on the spot, and the success of which was at all times very uncertain. Hence it has been superseded in almost all cases, and few living Surgeons have much experience of it. In popliteal aneurism, for which it used to be the only cure except amputation, it is now completely abandoned, having given place to milder and more certain methods. In femoral aneurisms, compression or the ligature of the external iliac would always be preferred; and so on for most of the common species of surgical aneurism. There are, however, some situations in which the old method still holds its ground in the estimation of at any rate some Surgeons. In axillary aneurism it has lately been recommended by the high authority of Mr. Syme, and enforced by the example of his successful application of it. In aneurism of the gluteal artery, should that rare disease be met with, many Surgeons would prefer cutting down on the sac and turning out the clot, especially in a traumatic aneurism, to the still more dangerous operation of securing the internal iliac artery;† and in traumatic aneurism at the bend of the elbow, if the disease resisted the proper application of pressure, it would perhaps be considered more safe to open the sac and tie the artery above and below, and would besides involve no more danger to life.

The leading idea of the old Surgeons in operating on aneurisms was doubtless an erroneous notion that it was necessary to get rid of the clot, which they believed to have vicious properties, and to be injurious both to the part in which it lay and to the constitution of the patient. So that they turned it out, not merely that they might find the mouth of the artery, but also, and mainly, in order to rid the constitution of so dangerous a secretion; and stuffed the cavity with compounds which they believed to have the property of preventing the reproduction of coagulum. All this theory is of course exploded now; and if the operation were undertaken in any case where there was much clot, the only object of the Surgeon in disturbing that clot would be to find the mouth of the sac. Still, when the clot has been disturbed and exposed to the air, it is better to remove it; and thus a large cavity is left to be filled up, and the extensive suppuration which this involves accounts for a large percentage of the great mortality after this procedure. Gangrene was very common after the old operation for popliteal aneurism, possibly from the difficulty of distinguishing the parts from each other, and the consequent frequency with which the vein and sometimes the nerve also was included in the ligatures. Another and a very frequent cause of death was the great liability to secondary hæmorrhage involved in this method as it used to be practised on diseased arteries. When used for traumatic aneurism, this objection does not apply, since the artery is as likely to be healthy in the neighbourhood of the wound as in any other part; but spontaneous aneurism usually occurs in consequence of atheroma in that part of the vessel; it is probable, therefore, that the ligatures will be applied to a brittle, degenerated artery, and will cut it through before any union has taken place. This danger, it is true, accompanies the Hunterian operation also, though to a less extent,* and there is more probability of finding the coats of the artery near the tumour sufficiently healthy for the application of the ligature in external than in internal aneurism; but even in the arteries of the limbs the neighbourhood of the tumour is the most insecure place at which an operation can be practised; and this was the main theoretical reason which set Hunter upon thinking of a new operation for aneurism.† The practical reason was doubtless the excessive mortality occasioned by the above-mentioned causes, and by the hæmorrhage during operation, which, in all cases where no tourniquet could be applied, was frightful, and sometimes instantly fatal,* and which was often severe even when the artery was commanded above the tumour, since, in a deep sac, it was necessary to let the vessel bleed in order to find its mouth. What the mortality was after this operation, practised as it usually was in the popliteal space, we have no means of judging, except by consulting the works of those Surgeons who, like Pelletan and Roux, have left the records of their individual experience; and it cannot be too often repeated that such data, though useful in many respects, are untrustworthy as statistics. Statistics of operations to be of any use or authority must be founded not on cases arbitrarily selected for publication, not even on the individual experience of distinguished operators, however fully and frankly given to the world, but on the general experience of large hospitals, embracing every case indiscriminately for a long series of years. This has never yet been fully effected or even attempted, and till a very few years ago was entirely unthought of. The mortality of every operation in ancient times must have been high, since the after treatment was far more arbitrary and artificial than at present; but what the proportion of deaths may have been we cannot now ascertain. Pott, in the well-known passage referred to on p. 372, says of this operation: "I have tried it myself more than once or twice; I have seen it tried by others; but the event has always been fatal:" and Wilmer of Coventry said that in the year 1780 there had not occurred in this country one well-authenticated case of success. However, in Pelletan's *Clinique Chirurgicale* (vol. ii. pp. 117-144) ther will be found notes of four operations of his own and six practise in Italy, in which success is claimed in no fewer than seven cases and in Roux's *Quarante Années* (vol. ii. p. 468) the only two recorded cases of the operation on the popliteal or femoral artery b opening the sac were successful. It is probable, therefore, tha Pott's view of the mortality of the operation was too gloomy

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* In a successful case, Pelletan made an incision ten inches long in operating on a recent popliteal aneurism, which is not stated to have been of remarkable size.

† But the diagnosis must be made with certainty. See the section on Pulsatile Tumours of Bone. In Mr. Syme's *Observations in Clinical Surgery*, 1861, pp. 165-173, will be found two interesting cases of gluteal aneurism, treated, one by the old operation, the other by ligature of the internal iliac artery, and both with success.

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* Especially in the arteries of the belly. See the account of an operation on the external iliac artery by Mr. Fergusson, *Med. Times*, vol. ii. 1855, p. 567. See also infr. on Abdominal Aneurism.

† "Mr. Hunter, finding an alteration of structure in the coats of the artery previous to its dilatation, and that the artery above the sac seldom unites when tied up in the operation for aneurism, so that as soon as the ligature comes away, the secondary bleeding destroys the patient, was led to conclude that a previous disease took place in the coats of the artery. . . . Mr. Hunter, from having made these observations, was led to propose that the artery should be taken up at some distance from the diseased part, so

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as to diminish the risk of hæmorrhage, and admit of the artery being mor readily secured, should any such accident happen. The force of the ci culation being thus taken off from the aneurismal sac, the progress of th disease would be stopped; and he thought it probable that if the par were left to themselves, the sac with its contents might be absorbed, an the whole of the tumour removed, which would render any opening in the sac unnecessary." Hunter's *Works*, vol. iii. pp. 596, 598.

* Roux, *Quarante Années*, &c. vol. ii. p. 46.

although the immediate success of the introduction of the Hunterian operation shows that the old method must have been far more fatal. Now the Hunterian operation on the femoral artery, as practised at present, gives, as we shall see, a mortality equal, or nearly so, to that of amputation of the thigh;* consequently the proportion of deaths after the old operation must have been something frightful.

The risk of hæmorrhage during the operation is a very formidable one when no tourniquet can be applied. Mr. Syme, however, has succeeded in several cases in getting through these dangerous operations without fatal hæmorrhage by the same expedient as he uses with such success in tying the vessels for wound; a proceeding to which the operation under consideration bears much analogy. He opens the sac at first by a moderate puncture, which allows him to introduce a finger into the sac and feel for the opening of the vessel. If this opening is not large enough, he dilates it so as to get in one and another finger, and in one case the whole hand up to the wrist, until the point is discovered at which the pressure of the fingers arrests bleeding. Meanwhile the opening in the skin is of course plugged by the fingers which have been thrust into it, so that no great gush of blood takes place. When the orifice of communication between the sac and the vessel has thus been commanded, the sac is opened freely and cleared of clots. Then the vessel is raised with forceps, if it is fairly visible, and tied. If the artery is not exposed, the operator must keep his finger still pressed on the orifice, while, with the aid of his assistants, he scratches away the tissues that obscure it. Further reference to these operations will be made in the sections treating of Carotid, Axillary, and Gluteal Aneurism.

The Hunterian Operation by Ligature.

The treatment of popliteal aneurism by ligature is one, and perhaps the most perfect, of the many discoveries of modern Surgeons.† It reduced a disease, which before was almost uniformly fatal, to the position of one of the most manageable of all serious surgical affections. It is true that in still more recent times a method has been discovered which is usually successful at even less risk to life; but this method of compression, though, as we shall see, it may commonly be reckoned upon in popliteal aneurism, may fail even there, and there are many arteries to which it is inapplicable; so that the Hunterian operation of tying the artery above the sac still is, and probably will long remain, the last resource of Surgeons in the graver cases of aneurism. Of so great a discovery and so happy a triumph of our art over difficulties which we, who have been taught how to combat them successfully, cannot estimate in their full magnitude, the history is always interesting, and the right appreciation of the claims of rival inventors is a matter of no slight importance. Unfortunately the limits of the present work do not allow of an adequate discussion of this subject, so that all that can be said about it must be comprised in a very few words, and it is more with a view of avoiding ambiguity or difficulty in reading foreign books, than of writing a portion of the History of Surgery, a task to which the present work makes no claim, that the following brief account is inserted of the rival claims of Hunter and Anel to the honour of giving his name to the operation now in use. This operation consists in securing the artery by a single ligature at a distance from the sac, and between it and the heart. The student will always bear in mind in reading most modern French works on Surgery, that they intend by the 'méthode d'Anel' the same thing as English, German, Italian, and American writers do by 'the Hunterian operation.' The essential difference between Hunter's and Anel's operations has been shown so often and so clearly, that it might have been expected that the unworthy attempt to deprive our great Surgeon of his due honour would have been long since given up. The countrymen of Petit, Paré, Dupuytren, Larrey, and a thousand other famous Surgeons, surely cannot be actuated by so puerile a motive as national vanity in the attempt to transfer to one of their compatriots the honour of discovering the best operation for aneurism. Yet, as the mistake they have been in the habit of committing on this subject is a somewhat obstinate one, and subsists even in the latest French work on the subject (that of M. Broca),

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* I do not, of course, mean that the operations are equally severe; but that about the same number of patients die after each. This is probably to be accounted for by the state of the circulating system and of the constitution which gives rise to aneurism.

† It is not intended to assert that the practice of tying arteries is a modern invention. "The Greek and Arabian physicians," says Mr. Hodgson (op. cit. p. 187), "more especially Ætius and Paulus of Ægina, distinctly

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recommended the ligature of the brachial artery a few fingers' breadth below the axilla for the cure of aneurism at the bend of the arm." But, like many surgical inventions of the ancients, it had been lost until its reintroduction by modern Surgeons in a more complete and more practicable shape.

the distinction between Anel's method and that of Hunter must be exposed here, though this will be done only cursorily, and as little space as possible will be wasted upon a question which has become rather personal than scientific.

The old method of operating for aneurism has been discussed, and its radical error has been seen to be, that its authors confounded what is in reality the effort of nature for the cure of the disease, viz. the deposit of laminated fibrin, with the essence of the malady itself; and instead of striving to encourage and promote this deposit, thought it necessary to undertake a severe operation for the purpose of removing all such clots from the system. Another, and hardly less fatal objection to its general application, was, that as the old Surgeons never contemplated the possibility of a cure of the aneurism without the entire suspension of the circulation, it was necessary, in their view, to tie the artery close above the tumour, and, this having been done, it was found out that the blood would usually escape from the lower end unless that was also tied.* The great merit of Hunter consists in his having avoided both these errors; in his having seen, *first*, that it was not necessary to turn the clots out of the aneurismal tumour, so that no incision was required to open the latter; and *second*, that it was not necessary to stop the circulation through it absolutely, but only, as he said, "to take off the force of the circulation," so that the artery might be taken up some distance from the sac, and therefore at a part where it would probably be found healthy; and further, in his perceiving that the ligature of the main artery of the limb does not involve the gangrene of the extremity, but that the anastomosing vessels may be trusted to carry on the circulation.†

From these considerations Hunter was led to propose the ligature of the artery at a point some distance above the sac for the cure of aneurism, the result of disease; and that he, at any rate, and his contemporaries thought that he was making a proposition of startling originality, is clear from the terms in which Hunter cautiously recommended it in his Lectures, and from those in which Bromfield commented upon what appeared to him its rashness and its dangers.‡ That it was equally new to Anel's countrymen

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* But some of the old operators used, as we have seen, one ligature only (p. 385, note). This fact should not be forgotten, as bearing on Anel's claims to originality in his invention.

† This had, however, been previously taught by Haller (quoted in Scarpa, Wishart's trans. p. 229).

‡ See Hunter's *Works*, vol. i. pp. 547 et seq.

(although seventy-five years had elapsed during which the operation devised by him might have been expected, had it rested upon any new principle, to revolutionise Surgery), is equally clear from a perusal of the pleasant work of Roux.* We read there, that while in England the great school of Hunter, and in Italy, Paletta, Vacca, and Scarpa, had every where spread abroad the use of the Hunterian operation, the old method was gaining ground more and more firmly in France, until M. Roux himself, after his return from England, reimported Hunter's operation, which, as we shall see, had been performed once by Desault. In fact, he says that it was not without astonishment that the Paris Surgeons heard of a practitioner at Angers having been rash enough to apply Hunter's method to a *traumatic aneurism in the bend of the elbow;* the very case on which Anel had operated. So utterly had the memory of this reputed discovery perished with its author. It may, however, be replied that, though Anel's operation failed to attract the same notice as Hunter's, this does not prove that they are not identical in principle; nor does it. Even if it were so, however, there would be no little injustice in passing silently over the merits of the man who excogitated the principle by profound reasoning, applied it in spite of searching hostile criticism, explained clearly the theory on which it rested, and succeeded thus in forcing the world's attention and imitation, in favour of one who was quite ignorant of the true principles on which the cure of the disease must be founded, and who, for any thing that appears to the contrary, was guided by pure chance to the selection, on perfectly false principles, of an operation which he never repeated, nor persuaded others to repeat. This would be so, had Anel even happened to stumble on the same operation as Hunter; but the truth is, that the operations are perfectly different,† and rest on different principles; and that while the one will probably succeed, the other will almost certainly fail in many cases where the aneurism is the result of disease.

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* *Quarante Années*, &c., vol. ii. p. 89.

† No better proof of the radical difference between the two operations can be required than is furnished by comparing two consecutive pages of a writer who persists in calling Hunter's method the 'méthode d'Anel;' see pp. 509, 510 of M. Broca's work. In the former page he is carefully and judiciously explaining the essential difference in their effect on the collateral circulation, and hence on the patient's chance of recovery; in the second (the passage commencing "étudions maintenant"), he has recurred to his habitual language, and speaks of them both under one common designation. To such an extent is this pedantry of error carried, that it is difficult at first to see that in the latter passage the common or Hunterian operation is spoken of under the name 'méthode d'Anel;' while in the former the same term signifies the now disused proceeding which that Surgeon adopted.

The case on which Anel operated has been often quoted, and is very well known. It need not here be related at length. The facts were these: a man had received a wound of the brachial artery in venesection. It is said that a fortnight afterwards an aneurism formed, and the wound reopened and gave rise to hæmorrhage, which was arrested by compression; and that after this, the tumour became very voluminous. What length of time had elapsed, and what the state of the tumour was, when Anel undertook his operation, we are not informed. The operation consisted in exposing the brachial artery, tying it as near the tumour as possible, and applying "the proper dressing and bandage." We are not told expressly whether the blood in the sac was solid or fluid; but it appears clear that it was in the latter state, and that the only reason which Anel had for not opening the sac, and emptying it of its contents, was that he was able to empty it by pressure. That this was so, appears implied in his own observations on the subject. He says, "Instead of tying the artery above and below the tumour, I only tied it above; and besides, instead of opening the sac, I did not meddle with it; not doubting that the blood which it contained would disappear, having the opportunity of passing towards the extremity of the limb, and that the sac once emptied would not fill again, but its tissues shrivel up, and the tumour thus disappear: and all this occurred as I expected." It seems clear, then, that if Anel expected the blood in the sac to pass on towards the hand, that blood must have been fluid, and probably the "suitable dressing and bandage," which he says he applied after the operation, may have had quite as much to do with the cure as the ligature of the artery; and, after all, the case may have been cured by direct pressure, an event not uncommon in recent traumatic aneurisms at the bend of the elbow. This is evidently quite a different operation from Hunter's; the only principle it has in common with his, is that of leaving the sac unopened; and few persons who read without prejudice Anel's confused and obscure account of his operation, will fail to see that the reason of his not meddling with the sac was most probably that it could be emptied by pressure. This view is again supported by the fact that Heister, who followed Anel's account, and apparently spoke on the authority of his single case,* advised its application only in 'reducible' aneurisms. Thus it does not appear that there was much of novelty in Anel's method, since it merely consisted in leaving to the fluid contents of the tumour an exit by the lower end of the artery instead of tying the latter, just as Keyslère had done; and it may very fairly be doubted whether what novelty there was, was not a mistake,* and whether Anel's case, in spite of its success, is not only another instance of haphazard good fortune. At any rate, the results which flowed from it before the time of Hunter did not seem to testify to the brilliancy of the discovery. The great learning and evident bias of M. Broca have only enabled him to adduce what he calls six instances of operations performed on this plan before the date of Hunter's first operation, a period of seventy-five years. Two of these are related in the loosest way by Bertrandi, as having occurred in the practice of some anonymous Surgeon, and were failures. Of the others, one was of the temporal artery, and two others of the humeral, all most probably traumatic, and all very likely curable without difficulty by very simple means. The sixth case is the celebrated operation of Desault. It would be impossible, without taking too much space from more important matter, to discuss this operation fully in its bearings upon the Hunterian method. It is sufficient to say, that it was performed on a case of popliteal aneurism of small size, strictly after the method of Anel, *i. e.* by tying the artery immediately on its entering the sac. It appears (notwithstanding what has been said to the contrary) to have been successful, at least in its immediate results: the ligature separated on the eighteenth day; the tumour burst and discharged its contents on the day following; this wound healed, and the tumour disappeared. The patient died eleven months afterwards of a disease of the tibia, which appears to have been totally unconnected with the operation. This, then, was precisely the same as Anel's operation, and therefore missed the second and third principles† illustrated by the method of Hunter; viz. that the artery may be tied at such a distance as still to allow circulation through the tumour, and that the previous increase of collateral branches is not necessary to avoid gangrene, and that therefore the artery may be tied at the most convenient spot.‡

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* Heister, *Instit. Chirurg.* pars ii. sec. i. ch. xiii. § 20, Amstelod. 1739, quoted by Broca, p. 446.

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* It seems as if Anel expected that the sac would empty itself, and would not again be filled; being ignorant of the reflux current and of the cure by coagulation.

† See p. 391.

‡ It would be unjust to deny the merit of Desault in applying the almost forgotten method of Anel to the treatment of that most formidable

The practical objections to Anel's method may be thus summed up. It leaves no current through the aneurism except the slight and weak reflux flow from the artery below. Consequently the clot formed will most likely be soft and loose, and the tumour will suppurate. It places under the ligature a part of the vessel, which is more likely to be diseased than any other portion. It is, in most cases, the most difficult of all methods of operation, since the artery is pressed back by the projection of the tumour, and is therefore at an unnatural depth,* while the operator has not the guide for finding it which a probe passed out of the sac would furnish. For all these reasons it seems that in any case where Anel's method was

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affection (as it then was), popliteal aneurism, and still more unjust to deny that the experience thence acquired might possibly, had he survived, and had Hunter not been in existence (in fact had all the circumstances been altered), have conducted him to Hunter's discovery; but it is monstrous to set up Desault, as M. Broca wishes to do, as the rival of Hunter, when, according to his own showing, Desault himself was quite content to pass as Hunter's scholar. "With a self-abnegation," as M. Broca amusingly says, "which his English detractors have been unable to appreciate, this great Surgeon, who then had become acquainted with the operation practised by Hunter, did not hesitate to adopt the precepts taught by his illustrious rival" (p. 454). Desault, in fact, was unaware of his title to the glory which M. Broca claims for him. As to the insinuation which M. Broca ventures to make, that Hunter was indebted for his operation to Desault by means of Assalini, who, according to him, was present at Desault's operation, and related its details to Hunter shortly afterwards in England, it refutes itself. The Hunterian operation was taken up nowhere more warmly than among the eminent Italians who were proud of being of the Hunterian school, as we have seen above from the contemporary account of M. Roux. Had one of their number conveyed to Hunter from Paris the first idea of the operation for aneurism, we may be quite sure that he, or some of his compatriots, would have said so. Assalini, an Italian Surgeon, was the only person present, as far as we know, both at Desault's operation and at the first operation of Hunter. It was mainly through Assalini that the new method of treating aneurism was brought into vogue in Italy. Assalini and all other Italians always speak of that method as Hunter's. Would this have been so, had Assalini taught it to Hunter from what he had himself learnt of Desault? But the fact seems to be, that Desault's operation, which was not brilliantly successful, and which he did not put forth as original, attracted little attention from himself or any body else; and that he had no desire, as he had certainly no right, to claim any priority over Hunter, whose teaching he, on the contrary, followed with great intelligence and great success in the single operation which he had subsequently an opportunity of practising.

* I exclude the comparatively rare case of the artery being raised and flattened by an aneurism growing into the deep parts. But here also I should imagine that the difficulty of distinguishing the vessel would incline the operator to resort to the opening of the sac.

feasible, the old operation would be equally practicable, and more certain of success.

The foregoing observations will, it is hoped, suffice to justify the use in the context of the name of Hunter in describing the operation which he is not denied to have invented in the form in which alone it is now practised, to have first performed, and to have afterwards, in spite of much opposition, introduced into general favour. If these things do not give claim to an invention, it is hard to see how such an honour is to be attained.

The Hunterian operation consists in tying the artery on which the aneurism is situated at any convenient distance above the sac. The operation, as it is now practised, differs in many important particulars from that which Hunter used to perform; particulars which have a most material influence upon its success, and which were impressed upon Hunter himself, and upon his scholars and successors, by the teaching of experience. Thus, Hunter used to tie the femoral artery at its lower part (in the fibrous sheath, called from that circumstance 'Hunter's canal'), an operation much more difficult and dangerous than the modification introduced by Scarpa.[*] Hunter, in his first operation, brought a large part of the walls of the artery into contact by four broad ligatures, somewhat loosely fastened, conceiving this disposition to be more favourable to the closure of the artery, which he described as taking place by the process of 'first intention.' His own experience, however, soon taught him to modify this form of ligature, and to use only one string; and the more extended experience and research of his successors (among whom Dr. Jones[†] has deservedly obtained the first place) have proved to demonstration, that the best form of ligature is a single stout thread, drawn tightly: accordingly no other form is any longer in use.[‡] Lastly, Hunter was not at first at all careful to avoid including the vein with the artery in the ligature; but this was an error which he soon gave up. So that the more material improvements were devised by Hunter himself; and in principle the first operation which he performed was identical with all that succeeded it.

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[*] On this head, see the section on Ligature of the Femoral Artery.

[†] *On Hæmorrhage.* Reference may also be made to Lisfranc, "Thèse de concours des diverses méthodes et des différens procédés pour l'oblitération des artères dans le traitement des anévrismes," Paris, 1834; South's *Chelius*, vol. ii. p. 219; Porta, *Delle Alterazioni patologiche delle Arterie*, &c., Milano, 1845.

[‡] In the *American Journal of the Medical Sciences*, Oct. 1859, p. 570, will be found a very interesting case, in which Dr. Warren Stone, of Louisiana, tied the common iliac artery with a silver ligature. The ligature was not drawn tight enough to cut through the internal coats of the artery, according to Dr. Stone's judgment; the ends were cut short and turned down, and so left. The patient died, apparently of causes unconnected with the operation, on the twenty-sixth day; but the symptoms after the operation are not

The effects upon an artery of the application of a ligature have been already detailed in a previous section of this work (see vol. i. pp. 674 et sqq.). While the changes there described are going on in the artery itself, the process of cure is progressing in the aneurism. We have seen already, that on the withdrawal or diminution of the force of the circulation, the preponderance of the heart being abated, the process of spontaneous cure commences. The ligature acts to a certain extent as Valsalva's method acts; that is to say, it diminishes the force with which the blood distends the sac, and thus gives opportunity for the coagulability of the blood and the resilience of the parts to fill the sac with firm laminated clot, and so effect the cure of the disease. It differs, however, from Valsalva's method in this important particular; that its action is local instead of general, and is therefore incomparably more certain and more safe. As the process by which the aneurism is filled, and the changes which it afterwards undergoes, are to a great extent the same after ligature as in the natural process of cure, the reader is referred on that head to what has been said above. But to that account it must be added, that since the surrounding parts are suddenly relieved from tension by the withdrawal of the expansive force of the aneurism, their resilience, and the compression they exercise upon the tumour, play a much more important part in the cure after ligature than in the spontaneous cure.

While the aneurism is becoming consolidated, the collateral circulation is enlarging, to convey the blood into the parts below the ligature. The meaning of this term is as follows: when an ar-

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fully given. The ligature, however, seems to have fulfilled its purpose. The body unfortunately was not examined, so that the condition of the ligature was not ascertained. It seems to have been intended by Dr. Stone to remain on the vessel permanently, without exciting any ulceration, and therefore without inducing risk of secondary hæmorrhage. I much doubt whether this would be so. At least, I have placed a silver ligature on the femoral artery of a dog, not drawing it tighter than appeared necessary just to stop the circulation, and found the coats of the vessel divided by it seven days afterwards. Silver ligatures do not excite ulceration when there is no tension upon them; but silver, or any other substance, when pressed firmly on the tissues (as a ligature must be upon a large artery) will always cause them to ulcerate.

tery has been tied at any given spot, the branch which leaves it next above the seat of the operation, and in their degree the branches above this, feel an increased pressure, in consequence of the neighbouring column of blood having been barred in the principal vessel. Hence they yield to the increased impulse, and become distended. The collateral arteries, by means of which they anastomose with the branches of the parent trunk below the ligature, increase, and increase probably in a much greater ratio than the larger vessels, in proportion to the greater tenuity of their coats. The facility with which the capillary and other small vessels allow of changes of volume is well known.* Thus a ready way is opened for the blood to return into the parent trunk below the seat of ligature. To make this clear by an example: say that the femoral has been tied (as it generally is) some distance below the origin of the profunda, in a case of popliteal aneurism. The blood will distend this artery and its branches, amongst others the external circumflex and its descending branch; which, joining with the superior external articular, and thus with the anastomotica magna, will be one of the arteries to convey the blood round the ligature back into the trunk of the femoral, below the obliterated spot. The number of such collateral arches of anastomosis is uncertain, but probably they are numerous in most cases, and include not named arteries only like that above adduced as an example; but a number of muscular and other branches, the anastomoses of which are so fine in the healthy state, that they escape our ordinary methods of injecting.†

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* The enlargement of the collateral vessels must depend upon the presence of some oxygen in the blood, as well as the sufficiency of the vis a tergo of the heart. If the former be absent, there is no attraction of blood to the capillaries in the distant part of the limb; and a local asphyxia, followed by gangrene, must ensue. Deficient vis a tergo would show itself by pallor and coldness, with shrinking of the distal parts; a defective capillary attraction, with sufficient vis a tergo, would be shown in a stationary venous condition, perhaps livid congestion of the limb; while if the vis and the attraction be both wanting, the limb must be simply cold and inactive—in fact, dying. The integrity of the walls of the anastomosing vessels is also an important condition in the restoration of the collateral circulation.

† The number of anastomosing branches varies considerably. Porta (op. cit.) figures a preparation in which he found between fifty and sixty. On the other hand, there is a preparation in the museum of St. Thomas's Hospital, in which the blood is brought down from the upper to the lower part of the brachial artery by a single branch the size of a crow-quill. Sir Astley Cooper states, probably referring to this preparation, as well as to that of a man whose thigh he amputated some years after an operation

The rapidity with which this process goes on cannot well be ascertained in the human subject. In animals it is known to be very rapid;[*] but in animals the process of repair in all injuries of vessels is very far more active than in men, so that in them gangrene never follows on the ligature of arteries. No sound conclusions, therefore, can be drawn from this experience. In men, however, the process seems to advance sometimes very rapidly in the upper extremity, where the natural anastomoses are free. Thus, in Anel's celebrated case, it is stated that the pulse could be felt at the wrist on the day after the ligature of the brachial. In Mayo's case of ligature of the subclavian,[†] the pulse was felt in the wrist on the fifth day, but disappeared afterwards; and in a case of popliteal aneurism operated on by Deschamps, pulsation was, it is said, felt in the sac seven hours after the operation.[‡] On the other

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for popliteal aneurism, that although the anastomosing vessels which enlarge immediately after the operation may be numerous, their number afterwards diminishes, those less necessary yielding their place, as it were, to a few, or perhaps to a single vessel, which may be found nearly in the place and nearly of the size of the original trunk. Wardrop, op. cit. p. 12; see also *Med.-Chir. Trans.* vol. xxv. p. 117. Two beautiful plates, the back and front view of a preparation in which the collateral circulation has been injected after ligature of the femoral, may be seen in Porta's work. The very free communication between the external circumflex, superior external articular, and anastomotica magna, is very clearly shown. There is also a large and direct arch of anastomosis between the latter artery and the internal circumflex. Thus the femoral and popliteal above the aneurism have been kept pervious, while below the aneurism the blood enters the popliteal by two great branches (inferior articular), which receive their supply from a large arterial net-work in front of the joint, derived from the arteries above mentioned (viz. profunda, anastomotica magna, external circumflex, and superior articular): a direct communication from this net-work to the tibial recurrent appears also to have reinforced the anterior tibial.

[*] See the experiments of M. Broca, op. cit. p. 507, note. He placed a ligature under the femoral artery of a dog in the groin; then amputated the leg at the knee, and noted the distance to which the pulsating jet extended, both during the systole and diastole of the heart. The ligature in the groin was then tightened, by which, of course, the bleeding was checked for the time; but it recommenced from the end of the popliteal artery at the end of one minute, and at the end of five minutes the jet (which, however, no longer pulsated) had attained a quarter of its former maximum, even though the quantity of blood in the body was less.

[†] *Med.-Chir. Trans.* vol. xvi. p. 363.

[‡] Wardrop remarks on this head: "The enlargement of the anastomosing vessels, to a certain extent, takes place almost instantly after the trunk has been tied. I observed this in a child in whom I had secured the carotid artery. I could see the branches of the temporal and occipital underneath the delicate integument enlarging, and thus actively acquiring

hand, in a case where the present writer had occasion to tie the axillary artery during an operation, the patient being a child, no pulse was perceptible in the radial for many months afterwards. In the lower extremity, in which the arteries are relatively fewer and their coats thicker, doubtless the collateral circulation is re-established more slowly than in the upper; hence the frequency of gangrene in the former after tying one of the principal trunks, while in the upper extremity it is very rare.* The enlargement of the collaterals has taken place to some extent before the operation in most, if not all, cases of aneurism, being occasioned by the obstacle to the circulation caused by the aneurismal tumour. The readiness of the return of pulsation will depend in a great measure upon the agents by which the circulation is restored. Thus, if one large branch join the artery below the ligature, the anastomosis being very likely effected principally by a single arch of artery joining this (as in Sir A. Cooper's case), pulsation will be restored quickly; if a large net-work of small branches carry on the circulation, it may be absent for an indefinite period. Whatever the period may be, it is certain that in a few days at the latest, either gangrene will set in, or the circulation will be so far reëstablished that the blood will flow through the artery, entering it by the branch which joins it below the ligature, and probably by many of the successive branches. Thus, when the ligature has been applied far away from the disease, the blood returns into the vessel above the aneurism; and so, if the tumour be not already filled with clot, the circulation through it may be reëstablished. This circulation is sometimes sufficient to prevent coagulation and to

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great additional vigour immediately after the operation." *On Aneurism*, p. 12. As to the time at which the process is completed, the following is extracted from Porta, op. cit. p. 223. "It is difficult to determine the time of the restoration of the collateral circulation after the ligature, inasmuch as it varies in different cases. Sometimes, after two or three months, the anastomotic circulation is so full, that it seems at the height of its development; while in other cases, six or eight months afterwards (always compared with the healthy limb) it may be said to be hardly matured. From my observations, I am led to believe that the collateral circulation is developed in a limb operated on in the space of a few months, and generally before the end of the first year; because, on analysing specimens at remoter epochs, after 12, 18, 24, 36 months, it is not found that the anastomotic system has progressed farther. This system is fully constituted at that time when it has attained the aim of its development, and has brought up the circulation to the measure of the requirements of the limb, and so is brought to a standstill."

* See on this point the sections on Axillary and Brachial Aneurism.

perpetuate the disease; and failures from this cause are occasionally, but rarely, noted. More commonly, the force of the circulation is sufficient to cause a sort of undulatory movement to become perceptible in the contents of the tumour a few days after the ligature; but coagulation is advancing, and will rapidly suppress this movement, which soon ceases to be appreciable. Now in these successful cases the anatomical condition of parts may be twofold. If the artery and aneurism form one channel, or if the aneurism stands off like a bud from the artery, the canal of the vessel may be left pervious,* and the circulation will be carried on through it. But in the great majority of aneurisms, which are neither fusiform nor pedunculated, but sessile, and involving more or less of the circumference of the vessel, the obliteration of the tumour involves that of the affected artery; and now another arch of anastomosis will often be required. The necessity for the formation of this lower arch of anastomosis will depend on the distance between the point of ligature and the aneurism, and on the number of branches which communicate with the main trunk between them. If the point of ligature be distant, as in the common operation for popliteal aneurism, or if many branches intervene, the artery will be pervious between the ligature and the tumour, and therefore two sets of collaterals must be developed; one to carry the blood round the seat of ligature, the other round the aneurism. There is no evidence to prove that this double call upon the powers of nature exercises an unfavourable influence on the prospects of the operation, although it is quite possible that it may do so. Thus, some of the cases of suppuration in the sac after ligature, such us those quoted on pp. 377, 8, may be due to imperfect development of collaterals round the aneurism, and the consequent persistence of the circulation through the tumour, which ought to be temporary only. It is probable, however, that the very fact of the existence of an aneurism exerts in most cases a retarding influence on the circulation through the trunk of the vessel, and thus induces a preliminary expansion of the branches immediately above it, so that the lower arch of anastomosis may be more easily formed than the upper; or the latter may take the place of both, the collaterals above the ligature communicating with the branches of the artery beyond the aneurism, as would be the case in an aneurism seated on the common carotid, where no branches intervene between the ligature and the tumour. In most cases, dissection after a successful operation will show the artery obliterated at the seat of ligature and at that of the aneurism, and pervious between them.*

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* The latter disposition of parts existed in a case where Sir A. Cooper tied the external iliac. See the account of the dissection in *Guy's Hospital Reports*, vol. i. I have not met with a case of the former disposition after ligature; but it may be seen after spontaneous cure in Hodgson's case, quoted on p. 374; and after the cure by pressure in a preparation in St. George's Hospital museum, referred to on p. 420. In the first case of ligature of the internal iliac, by Dr. Stevens, the pelvis was brought over to this country for dissection, the patient having survived the operation ten years. The account (by Prof. Owen) of the dissection may be found in *Med.-Chir. Trans.* vol. xvi., and there it is noticed that the aneurism (which was of the tubular kind) had in the centre a cavity containing only loose coagula; but no circulation had gone on through it.

The immediate effect of a ligature applied to a main trunk is of course to suspend for the time the supply of blood and the vis a tergo of the heart. Hence congestion of the blood in the extremity, and hence temporary rise of temperature.† Another immediate and necessary effect of the ligature is the temporary loss of power in the parts supplied by the obliterated artery. This phenomenon is not so often observed in men, since the conditions of their treatment prevent any attempt at movement of the limb operated on;‡ hence a tingling and numbness is generally all that is complained of; but it can easily be verified on animals. Thus, after ligature of the abdominal aorta in a dog, the animal will be noticed to drag his hind legs just as if he had received a severe injury to the spine. Sometimes in men, although the immediate paralysis may pass unobserved, its effects will persist, and a partial loss of motion in the limb will be permanent. Still more often the nutrition of the part is impaired, so that the member is thinner, colder, and weaker than the other. This I have myself noticed in the case of the child above referred to, in whom the axillary artery had been tied. When she was last seen (more than a year after the operation), the arm, although it was the right, was decidedly smaller and weaker than the other. Thus also gangrene, from accidental exposure to cold, may occur long afterwards in the toes in cases where the femoral artery has been tied, even when no symptom of gangrene has followed immediately on the operation. These unfavourable consequences should not be lost sight of in determining the question of ligature or compression. They depend in all probability on a defective development, either in size or number, of the collaterals, by which the nutrition of the parts is diminished, the conducting property of the nerves probably suspended, and the irritability of the muscles impaired. Mr. Liston thought that the excessive development of anastomosing branches running in the substance of nerves, such as the comes nervi ischiatici, might produce paralysis. This seems improbable, but receives a certain amount of support from a case related by Porta, and from some observations which he has made upon it.*

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* For a collection of several cases in which the femoral artery was found pervious between the ligature and the aneurism, see Wishart's *Scarpa*, pp. 263-4.

† See Dr. J. R. Wood's case, in Report of Surgical Practice of Belle Vue Hospital, *N. Y. Jour. of Med.* 1858, p. 239; and Mr. Lawrence's, in *Med.-Chir. Trans.* vol. vi. p. 206. It will be remarked in the latter case, one of ligature of the external iliac, that though the ham on the affected side was warmer than on the sound side, the foot was always colder. It is interesting to observe, that in experiments on animals this rise of temperature does not take place, the activity of the collateral circulation preventing even temporary congestion. See Broca, p. 507.

‡ But sometimes slight and transient paralysis of motion or sensation is observed. See Mr. Chamberlaine's case of ligature of the axillary artery, *Med.-Chir. Trans.* vol. vi. p. 131.

Causes of death after ligature. The chief dangers following the operation are from gangrene and secondary hæmorrhage,† excluding

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* See Porta, op. cit. p. 381.

† In the *American Journal of Medical Science*, new series, vols. x. xiii. xiv. xviii. xl., are some excellent statistical papers upon the ligature of the principal arteries, viz. the subclavian, carotid, femoral, external, internal, and common iliac, showing the proportion and causes of death in each operation. The former papers are from the pen of Dr. Norris; the last is by Dr. Stephen Smith. As they display an amount of mortality after these operations which is probably not generally known, it may be as well to quote all these statistics together.

Ligature of	No. of cases collected.	No. of deaths.	Per cent.
Subclavian	69	33	47·8
Carotid	149	54	36·2
Femoral	204	50	24·5
External iliac	118	33	27·9
Internal iliac	7	3	42·8
Common iliac	32	25	78·1
Total	579	198	33·1

If the reader will compare these returns with the most complete statistics hitherto obtained of the mortality after other surgical operations, as those of amputation by Mr. Bryant in *Med.-Chir. Trans.* vol. xlii., he will at once see that the ligature of the main artery of a limb involves the gravest dangers, and is an operation which should only be undertaken in the face of evident necessity. The above returns might have been made still more unfavourable by collecting the cases of ligature of the two largest arteries —the aorta and innominate—which have proved uniformly fatal; but it was thought better not to include operations which many persons consider the complications to which all operations are exposed, and the special dangers which result in tying individual arteries from their anatomical relations, and which will be discussed in speaking of the special operations. Gangrene is perhaps a more frequent cause of death than hæmorrhage after ligature of arteries in the lower extremity.* In the upper extremity, the anastomoses are so frequent, that the parts are nearly in the same conditions as in the lower animals, in whom gangrene is, as we have seen, unknown. The causes of gangrene are, a deficiency in number or in extensibility of the collateral branches, or a want of due care in maintaining the temperature of the part after the operation, constricting the limb with bandages, or, finally, some injury done to the principal vein of the limb during the operation.† Little can be done to

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unjustifiable, and which will probably be soon banished from surgical practice.

By comparing Mr. Bryant's table, it will be seen that the ligature even of the femoral artery, the lowest in this list, is almost as fatal as amputation of the thigh (which appears in that table as fatal in 27·27 per cent of cases), while most of the others approach the mortality of primary amputations.

These considerations show strongly the propriety of avoiding ligature of a large artery whenever there is any prospect of curing the disease by any other method. The table in Porta's work (p. 404) gives a similar conclusion. It contains a synopsis of 600 cases, and might perhaps have been expected to be somewhat more favourable than the above statistics; as, although it includes 12 cases of ligature of the aorta and innominate (which were of course uniformly fatal), it also comprises 68 of ligature of the brachial, an operation which is generally successful. Still the deaths are 167, or more than 27 per cent; nor does it show a much more favourable average in any operations except the ligature of the subclavian and common carotid. The difference, however, between Porta's statistics of these operations and those of Norris depends, I have no doubt, merely on some of the published fatal cases having escaped Porta's investigation. The real averages are probably more unfavourable; fatal cases having remained unpublished. At least this conclusion is supported both by what we know of the nature of published cases, and by the experience of English Surgeons in the ligature of arteries, as shown in the statistics of the *Medical Times and Gazette*, which will be again referred to.

* Of the fifty fatal cases of ligature of the femoral artery in Norris's table, twenty-three are stated to have died of gangrene and only eight of hæmorrhage; but this point will be again referred to under the ligature of the individual arteries.

† That gangrene is often due to injury of the vein is an opinion which Mr. Syme has strongly insisted on (*Principles of Surgery*, 1856, p. 99). He even appears to go so far as to allege this as the only cause of gangrene, discrediting the received opinion (which has just been stated above) entirely. But that gangrene may occur when no injury has been done to the vein is proved by numerous facts. Amongst others, a preparation exists in the museum of St. George's Hospital, with a record of a careful dissection by

obviate the first cause of failure. It may be suspected, in persons of weak circulation and exhausted by old age or excess, that in the former case their arteries may possibly not anastomose very freely, while the latter class are nearly sure to labour under an atheromatous condition of the vessels. Hence both are bad subjects for the ligature of an important artery; but as these operations are now never performed unless under circumstances of urgency, in which all risks must be run, a knowledge of the state of the arteries, even if it could be certainly attained, would, after all, only affect prognosis. Much may, however, be done to prevent gangrene by maintaining the temperature of the part. It would seem at first sight inconsistent to talk of the necessity of keeping up the temperature in an extremity in which, as we have seen, it has already risen above the standard of health. But this contradiction is only apparent. The temperature of the toes rises after ligature of the femoral artery, not from increased power in the part, or increased vital activity, in which case it would clearly be wrong to add fuel to the fire, but from diminution of the vis a tergo of the heart, and consequent stagnation of the blood in the extreme vessels. Expose the part to cold—the tissues will contract upon and unload the vessels, which will themselves also be constricted by the cold—and the part will not only be deprived of blood, but a powerful obstacle will be offered to the weakened circulation by the rigid and contracted state of the vessels and the parts which support them; an obstacle which most probably will be found insurmountable. Hence the importance of maintaining the limb as near the natural temperature of the body as possible. It should not be much warmer, since parts in which the circulation is imperfect are as little able to resist heat as cold: thus gangrene has followed the application of hot salt or sand-bags to

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the late Mr. Gray, in which the vein was clearly proved to be perfectly healthy and uninjured, yet the patient died of gangrene. The vein has also been known to be included in many operations on the femoral artery without any symptom of gangrene. John Hunter at first purposely tied up the vein, and Roux has confessed to having done so accidentally. Langenbeck (*Archiv für Kl. Chir.* vol. i. pt. 1) and Gibson (*Am. Journ. of Med. Sc.* vol. xiii. p. 305) have both tied the internal jugular vein and carotid artery in extirpating tumours, Cooper of San Francisco (*New York Journ. of Med.* 1857, vol. iii. ser. iii. p. 410) the external iliac vein and artery in a case of aneurism, with good results. The *partial* ligature of the vein, in which the thread is left like a seton in the cavity of the vessel, is much more likely to be followed by fatal effects. Mr. Carmichael and others have spoken of the occurrence of phlebitis and obliteration of the vein, sometimes followed by gangrene, as a consequence of injury to the vein (see Broca, p. 479).

the limb. The best application is carded wool, which merely retains the natural warmth, and has the additional merit of retaining it without requiring renewal, while it allows the occasional inspection of the limb if required. It is advisable, however, to make such inspection only rarely, since it cannot be done without some change of temperature, which, if often repeated, might have a prejudicial effect. The wool should be used in large quantity, so as to form a thick layer around the whole limb, nearly as high as the seat of operation, and secured by a bandage loosely twisted round. It will be understood that the limb should be kept in such a position as to facilitate the return of blood.*

The patient's diet and regimen should not be too rigid. This will of course be regulated by his previous habits; and the same may be said of the exhibition of opium. In persons of dissipated lives and nervous temperaments, stimulants and moderate quantities of opium must be allowed; while robust persons, with equable and tolerably strong pulse (who, however, are rarely the subjects of aneurism), will do better on a nourishing but unstimulating diet.

When gangrene has once declared itself, which usually occurs on the second to the fourth day,† the case becomes grave; but the prognosis is not hopeless.‡ All depends on the rapidity with which the mortification advances. If, as is sometimes the case, it shows itself not merely in the ends of the toes, but simultaneously on the dorsum of the foot, and advances with rapidity, no time should be lost in amputating, and the limb should be removed as near the seat of ligature as may be found convenient. It is not absolutely necessary to operate at, or above, the place where the artery has been tied. The portion of the limb just below this spot is nourished, not from the obliterated part of the vessel, but by the branches of a higher origin, so that there is no fear of sloughing of the stump.

When the gangrene, on the contrary, appears only in one toe, or in the contiguous portion of the extremity of more than one, and extends slowly in the continuity of the limb, hope may rationally be entertained of preserving the member. The case must be treated like any other case of gangrene, by local warmth, local and general stimulants, and opium, with due regard to the patient's constitution, nervous temperament, and general symptoms. I venture to think that the attempt to preserve limbs after gangrene the result of ligature is not, generally speaking, carried far enough. The prognosis of amputation in these circumstances is not very favourable; the cases closely resembling those of secondary amputation, the most fatal, according to Mr. Bryant,* of all classes of amputation.† Suppuration and sloughing of the sac is a kind of gangrene, and is one of the chief causes of death after ligature. It sometimes gives rise to hæmorrhage; but more frequently it poisons the blood, and leads to death either by pyæmia, or by that systemic infection of which pyæmia is the local manifestation.

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* Mr. Guthrie's favourite method for obviating gangrene was to have the limb constantly chafed by the attendants.

† Although sometimes not till the second or third week. Porta, op. cit. p. 393.

‡ The mortality is estimated by Porta at 71 per cent.

The other cause of death, that from secondary hæmorrhage, has been already treated of in the essay on INJURIES OF THE VESSELS, vol. i. p. 676. It is more common in the upper extremity, where the heart is near, the circulation powerful, and the processes more rapid, than in the lower. It is also more to be apprehended after ligature for aneurism, when the artery is more likely to be diseased at the point operated on, than for wound, when it will, in all probability, be healthy.‡

Besides these causes of death after ligature, the operation sometimes fails to cure the aneurism, though the patient survives. This, indeed, is rare; but it seems to occur in two ways. Either the pulsation never disappears in the tumour, and the latter, perhaps after a temporary check, continues growing in size, and will ultimately burst; or the aneurism diminishes, becomes solid, and undergoes a process of apparent cure, but then, after a longer or shorter period of quiescence, the pulsation reappears, sometimes with a sudden increase in size, and the disease is said to recur.

When the ligature fails to abolish the pulsation, this depends again on one of two causes. The artery may have connected with it a 'vas aberrans,' by which the blood is brought directly down into the tumour. Such was the state of parts in Sir C. Bell's case of ligature of the femoral artery.§ This condition of the vessels, however, will not escape the attention of a careful and well-instructed operator; and the fact that tightening the ligature has not its usual effect on the pulsation of the aneurism, will show that the latter must either be seated on some other vessel, or, at any rate, must communicate as freely with another vessel as with the one tied. Accordingly this other vessel must be sought for by careful dissection; and until it is found the original ligature is not to be tightened. If there be a vas aberrans, the other vessel will be at no great distance, and should be tied at once. When this has been done, if pulsation is quite abolished in the aneurism, it will perhaps be unnecessary to tie the vessel first exposed; but it will be more prudent to leave the ligature (which has been already passed) under it, to be tied on the first symptom of returning pulsation in the tumour. These anatomical anomalies are so rare as to be merely surgical curiosities; still they should be borne in mind. It more frequently occurs that the circulation through the aneurism, temporarily abolished by the ligature, returns in a few hours or days, and continues to increase till it reaches its previous force, and the disease runs its course apparently unaffected by the operation.* This accident must be due to the preternatural activity of the collateral circulation; and it is one which it is difficult to meet with appropriate treatment. In the first place, it seems reasonable that nothing should be done until the limb appears beyond the risk of gangrene, and until the pulsation is plainly permanent; and this cannot be said to be the case until the tumour has been pulsating very distinctly for some months, and the pulsation shows no tendency to abate. It should always be borne in mind that a slight undulatory pulsation in an aneurism on the second or third day after ligature is a very usual phenomenon, and so far from being of evil augury, is considered by many authors to be a favourable sign, rendering it more probable that laminated clot will form, since for this process, as has been shown, some amount of circulation is necessary. It is assumed that, previous to the original operation, compression of the artery above the tumour has either been tried and failed, or was contra-indicated. Hence it will be probably useless to recur to that method. Direct pressure, or genuflexion or forcible flexion of the elbow, if the aneurism be in the forearm, with appropriate bandaging of the limb, will of course be tried. When these measures fail, two courses are open,—either to tie the artery lower down, between the ligature and the aneurism, or to perform the old operation of opening the sac and tying the artery as it enters and leaves it. As a general rule, the former method will be preferable in the lower extremity, the latter in the upper. Or if the Surgeon has sufficient confidence in such measures, he may resort to galvano-puncture, or to the injection of perchloride of iron (see below the sections which treat of these methods of curing aneurism). The ligature of the main trunk above the original operation has been tried, but it appears to be contra-indicated both by theory and practice.*

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* *Med.-Chir. Trans.* vol. xlii.

† Of forty-nine cases of gangrene after ligature, fourteen recovered; ten of these without, and only four after, amputation. Porta, op. cit. p. 394.

‡ See also the sections on ligature of individual arteries.

§ *London Medical and Physical Journal*, vol. lvi. p. 134.

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* The *temporary* return of pulsation is not so uncommon. Porta remarks on this head: "Out of 448 cases of aneurism and aneurismal varix cured by the Hunterian operation, there was in twenty-five cases a relapse; that is to say, a manifest reappearance of pulsation in the tumour; but the pulsation was temporary, lasting from a few weeks to some months, and then disappearing. The case, however, above related of Miloni, and the two published cases under the care of Cooper and Roux, show that even in the thigh the anastomosis may enlarge to such a point as to annul the action of the ligature. Such cases are fortunately most rare. Relapse would occur much more frequently in the neck and elbow, where the anastomoses are naturally so ample and direct, were it not that the aneurism, however small, already contains some clot; and the blood, directly on the application of the ligature, being reduced for some days to the minimum of movement in the trunk operated on, ceases during that time to feed the tumour and the aneurismal artery, so allowing the obliteration of both by fresh clot" (op. cit. p. 385). The three cases referred to will be found in Porta, p. 378; *Brit. and For. Med. Rev.* vol. vi. p. 67; *Bolletino di Bologna*, an. xiii. series 2, vol. xi. p. 185. Another case, which illustrates the return of circulation after ligature, occurred in Mr. Stanley's practice. He tied the posterior tibial artery low down in the leg for wound, using two ligatures at some distance from the opening. Hæmorrhage continued; and he had to place other threads closer to the hole in the artery. Ormerod, *Clinical Collections*, p. 151.

The recurrence of aneurism is, however, usually observed at a later period, after the persistence of the apparent cure for weeks or months. This was the case with a patient of Mr. Spence, of Edinburgh, in whom the aneurism was afterwards cured by genuflexion. The case will be found quoted lower down. It does not appear that the cure was ever a sound one after the ligature; and the pulsation in the aneurism was never abolished, though on the patient's first discharge it had been reduced to a line which was thought not to be more extensive than that of the popliteal on the other side. Cases such as this fail from the faulty formation of the clot. The sac is filled not with laminated coagulum, but in part, at least, with mere soft clots; and these clots in the course of time soften and yield to the force of the circulation, or pass into its current. When this is the case, the affair becomes even more grave than when the disease recurs from the causes mentioned in the last paragraph, since the too rapid development of the collaterals is, after all, rather a phenomenon of over vitality than otherwise;

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* As to the three cases mentioned in the previous note:—in Astley Cooper's case the artery was tied close above the sac successfully: in Porta's case the external iliac was tied; but the patient died of the operation: in Roux's case no treatment seems to have been adopted.

while, on the contrary, this indisposition of the blood to form laminated coagula under the usual conditions, appears to testify to some profound alteration in the vital current itself. The prognosis, therefore, will be worse than in the latter case; but the treatment must be the same, since no more radical measures are at hand except amputation; and to this no judicious Surgeon will have recourse until he is clearly certain that life is compromised by its delay.

Such are the causes of failure, and the methods, at the best very uncertain of success, by which they may be met. But in the great majority of cases in which the patient survives the operation, matters progress quite otherwise. The ligature, after a certain length of time (which varies, generally between about ten days and a month, according to the size of the vessel, the neatness with which it has been separated from contiguous parts, and the rapidity of vital changes in the patient operated on), cuts through the artery, and comes away with the discharge. The wound then heals, the divided ends of the artery reunite, and the whole of the obliterated portion of the vessel degenerates into a fibrous cord. The tumour, at the same time, consolidates more or less rapidly; the undulating movement, which was perceptible in it at first, disappearing as the deposition of laminated coagulum advances, until at length the whole is consolidated, and then begins to shrink. Finally, as after the spontaneous cure, a small hard tumour remains, like a walnut, which, if cut into, displays a structure something like that of an onion. With the exception of the obliteration of the artery at these two points (for the persistence of circulation through or past the aneurism is rare), and the consequent development of collaterals, every thing in the limb is natural. In other cases, the weakness and the faults of nutrition, which always attend at first upon the ligature of the main trunk of a limb, persist, and occasion atrophy of the muscles, fatty degeneration, &c.

Such is the mode of action, and such the effects of tying the main artery of a limb above the sac of an aneurism, as Hunter directed. If it is necessary to express an opinion as to the cases in which this plan is indicated, the best formulæ perhaps would be as follows:

1. It is indicated whenever the aneurism (which must always be supposed to be in an active condition, and advancing, or threatening to advance) is situated upon an artery inaccessible to pressure, but which will allow a ligature to be put round it without excessive danger, and with a sufficient space between the part tied and the tumour, of which the iliac arteries furnish the best example.

2. When, in an aneurism differently situated, the patient, from nervous irritability, drunkenness, or any other cause, is intolerant of more gradual methods, such as pressure, genuflexion, &c.*

3. When these methods have been tried and failed.

4. When an aneurism has burst into one of the internal cavities of the body, *e.g.* a popliteal aneurism into the knee-joint. For a very interesting example of cure by ligature of the femoral, even after this formidable complication, the reader is referred to a case which occurred at the Middlesex Hospital, under the care of Mr. Moore, and which will be found reported in the *British Medical Journal*, 1859, p. 489.

5. When the rupture has taken place subcutaneously, amputation or the ligature is generally indicated; still, in some of the less grave cases, it may be possible to obtain a cure by compression, but the attempt should not be too long persisted in; while, if the symptoms are urgent, or if gangrene have commenced, amputation is the only resource.†

Internal aneurism does not absolutely contra-indicate the operation. Dr. Crisp (p. 189) says that several cases are recorded where persons with aneurism of the thoracic aorta have survived the operation. But, in one celebrated case, the patient died on the table, from rupture of an internal aneurism, just as the operation was being begun. This accident would now probably have been avoided by the quietness and absence of agitation produced by anæsthesia.

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* Such intolerance must not, however, be too hastily admitted. Almost every person of ordinary good sense, and even of less than ordinary resolution, may be educated, by the gradual and transient use of digital pressure first, and the pressure of instruments afterwards, to bear the amount and duration of compression which is requisite.

† The subject of rupture of aneurism has been referred to above (p. 358). A paper by Samuel Cooper in *Med.-Chir. Trans.*, vol. xvi., will repay perusal. He points out that the pain is not always severe, that the shape of the tumour may be not much altered, and that, beyond a little purple discoloration, no trace of ecchymosis may be noticed. In these cases he is inclined to lay great stress upon the persistence of bruit, combined with the absence or gradual disappearance of pulsation, and a sudden fall in the temperature of the limb. Mr. Poland's paper, in *Guy's Hospital Reports*, 3d series, vol. vi., contains notes of 42 cases in which the sac of a popliteal aneurism burst, and of the result of the treatment. In 2 no treatment was adopted; in 1 of these the tumour burst externally, but the patient survived the bleeding and recovered. In 24 compression was used; which succeeded in 2 cases. In 16 the femoral artery was tied: 10 recovered without, and 2 after, amputation; 4 died,—3 of gangrene, 1 after amputation on account of suppuration of the sac.

Contra-indications to ligature. The late Mr. Aston Key has declared that, in his opinion, "the only circumstance that ought to deter a Surgeon from putting a ligature around any artery in the human body (not excepting the aorta) is, the uniform cessation of circulation in the parts below the ligature."* But if we regard the preservation of the patient's life as the ultimate end of all operations, we must surely allow that any proceeding which is uniformly followed by death is unjustifiable, by whatever cause or causes death may have been produced; and, still more clearly so, if the disease for which the operation has been undertaken has been known to be cured by other means. To both these objections the operations for securing the aorta and innominate artery are fairly liable. On the first head, it may indeed be urged that the number of cases of ligature is as yet insufficient to allow of our asserting that these operations are uniformly fatal. This is a point which must be left to the judgment of those who may be called upon to decide on the treatment of a case of this nature; but on the second head there is no doubt. Aneurisms at the root of the neck and in the belly have often yielded to medical treatment or undergone spontaneous cure, while they have as yet never been cured by operation. So that, if ligature be used at all in these aneurisms, it should only be as a last resort, when they have burst or are on the point of bursting, or when they are increasing under the best medical treatment which can be procured.† Again, the ligature should never be applied to any artery which is so situated as to admit of compression, unless that treatment has been tried and failed, or is contra-indicated by some peculiarity in the case. Nor should the ligature be used in cases of recent traumatic aneurism, particularly when caused by fracture, without a previous trial of the resources of nature, aided by such means as rest, position, careful bandaging, and pressure direct and indirect. Such cases, as we shall see, are peculiarly likely to undergo spontaneous cure. Nor should the ligature be used if the whole or a great part of the arterial system is diseased. In such cases digital compression is the most appropriate and safest treatment.

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* *Med.-Chir. Trans.* vol. xiii. p. 8.

† In such a case as the one in which Sir A. Cooper tied the aorta, viz. when the aneurism had opened externally, we may allow that the operation was the only conceivable means of giving the patient a chance for his life, and was equally creditable to the boldness and dexterity of the Surgeon. If it be objected that the rules laid down in the text would prevent operations in the root of the neck altogether, since, unless the artery is tied early, it will be out of reach,—I would reply, that this argument would show the ligature of the innominate to be an unjustifiable proceeding; for in an early stage of aneurism at the root of the neck, the patient has some chance of spontaneous cure, and a good chance of surviving a tolerably long period, while after the operation his life will, in all probability, be reckoned by hours.

TREATMENT BY INSTRUMENTAL COMPRESSION.

The treatment of aneurism by compression is a practice of almost as old a date as that by ligature;* but, like it, had fallen out of use from certain imperfections in its details, until it was taken up again, improved, and fitted for practical use by modern Surgeons. The old treatment consisted in the application of continuous pressure either to the sac, to the artery above it, or to both; and the cause of its frequent failure, or rather of the great rarity of its success in the hands of the ancient Surgeons, arose from their ignorance of the natural process, as we have above attempted to describe it, which effects the cure of aneurisms. Not being aware that the deposition of laminated clot, when once begun, would go on, under favourable circumstances, to the entire obliteration of the sac in almost every case, and that, for the commencement of that coagulation, only a moderate check to the circulation would suffice, they always aimed at suppressing the circulation through the aneurism altogether,† and if possible bringing the sides of the sac into contact. It was therefore necessary, in their opinion, to use such an amount of pressure as could hardly be tolerated by any one of ordinary sensitiveness, and which, even if borne by the patient, was pretty sure to produce sloughing. It was from a similar ignorance of the curative powers of nature, and of the ease with which the nice balance between the force of the circulation and the reaction of the arterial walls may be restored, that the Hunterian operation, which had been recommended by the Greek and Arabian writers (whether practised or not, is another question), fell out of notice till that great Surgeon reinvented it. Thus, in reading accounts of Guattani's cases, and of others in which the old Surgeons attempted to cure aneurism by compression, we are at once struck by the fact, that the pressure was always either too severe or applied to the wrong part, and often both. For as they thought that the principal point was to exclude the blood from the sac, of course the chief means of doing so was to empty the sac by direct pressure. When this was impossible, the next thing was to compress the artery above so firmly that no blood could pass. The modern system is entirely different in principle, and is a strict imitation of the process of spontaneous cure. We have seen that when an aneurism is cured spontaneously, it is in consequence of the circulation having received some partial check, by which laminated coagulum is deposited within the sac. Just so in the cure of aneurism by compression. It is merely necessary to lessen the force of the circulation through the aneurism during some considerable part of each day, and then usually in a few days, but sometimes not till the end of several weeks, it will be noticed that the œdema and venous congestion have quickly subsided, and that pulsation is diminishing in the tumour, that its contents are more solid (which may be known by its varying less in size according as the blood is shut off or let in from the artery when the finger is pressed on it), and that the anastomosing branches are increasing so as to be felt pulsating. When these signs are present, we may be pretty sure that the cure of the aneurism is not far distant.

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* Heister is said to have been the earliest author who recommended pressure in the cure of aneurism, and Guattani the first Surgeon who used it with success; but this was direct pressure. See Bellingham *on Aneurism.*

† It may be interesting to recal Hunter's case: "The aneurism was in the femoral artery, and the swelling appeared upon the anterior part of the thigh, a little above the middle, extending upwards nearly to Poupart's ligament. An attempt was made, by compressing the artery above the tumour by means of an instrument somewhat resembling a steel truss, to give the blood in the sac a chance of coagulating, and by that means put a stop to the progress of the disease. But, from the pain which it occasioned, every attempt to make a permanent compression on the artery proved ineffectual." He then proceeds to describe the progress of the case, the aneurism undergoing a spontaneous cure. Hunter's *Works*, vol. iii. p. 602. The pressure appears to have been applied too strongly, too constantly, and too much in one place. Yet Hunter was fully aware that the cure of aneurism was quite compatible with the persistence of circulation. Much more would Surgeons who thought it necessary altogether to abolish the circulation fall into such errors.

It would be wrong to pass over in silence the history of this method, although the length to which this essay necessarily extends prevents me from saying more than a very few words on the part played by the Irish Surgeons in introducing the treatment of aneurism by compression, and on the gratifying success which has attended that treatment.

It has been noticed above, that Hunter treated a case of femoral aneurism by compression on the artery between the tumour and the heart (indirect pressure); and the same plan was adopted by Sir W. Blizard,* and is strongly advocated by Mr. Freer;† but the latter Surgeon, and probably all who preceded those of the Irish school, unless Hunter be an exception, thought that pressure was to act by obliterating the artery. The pain was very great, in consequence of the assumed necessity of making very firm pressure always in the same spot; nevertheless some few cures were obtained under the care of Pelletan (or Echard), Dubois, Dupuytren, Boyer, and Albers, and are quoted in Dr. Bellingham's work; but these cases of success were balanced by failures, which, according to Dr. Bellingham, were "still more numerous;" and the treatment was so painful and so uncertain, that it seemed likely to fall into complete discredit, until Mr. Todd of Dublin recommended the use of the plan as an adjuvant to the Hunterian operation; his object being, by preliminary pressure on the trunk of the femoral, to cause the dilatation of the collateral branches, and so to lessen the risk of gangrene. For this purpose he made use of the instrument originally invented by Heister; but no striking results followed from this practice,‡ which was adopted by some Surgeons in Dublin and decried by others, but regarded by all merely as an accessory to the ligature, until the accidental success of pressure applied in the case of a patient of Dr. Hutton's (Oct. 3, 1842), who refused to submit to the operation, shortly followed by similar success on a patient of Mr. Cusack's, whose health appeared too broken to enable him to survive the ligature, led to a better appreciation of the matter; and the striking success obtained in a patient of Dr. Bellingham's, the aneurism being cured in two days, drew the attention of Surgeons in other countries to the matter, and successful cases followed, not only at Dublin, but also at University College Hospital under Mr. Liston's care, and in other parts of the kingdom. Still the great majority of the cases were treated in Ireland; and it is to the Irish Surgeons, and especially to Dr. Bellingham, that the Profession is indebted for the true theory of this method of cure. Their success in the application of the treatment has also been much greater than has been obtained in London. In Dr. Bellingham's small but very valuable work on Aneurism§ (from which the above particulars are extracted) may be found short notes of twenty-five cases (most of them treated in Ireland) in which compression was used, and which included all that had been reported up to that date. In only one of these was it found necessary to resort to ligature of the artery, and then not on account of the failure of the method, but in obedience to the wishes of the patient, who seems to have got tired of the treatment, though it appeared on the point of succeeding. (See also Tufnell's work.)

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* Bellingham, op. cit. p. 28.

† *On Aneurism*, pp. 94, et sqq.

‡ It is said, however, to have effected a cure in one unpublished case. Tufnell *on the Treatment of Aneurism by Compression*. p. 27.

§ *Observations on Aneurism, and its Treatment by Compression*, Dublin, 1847. I exclude two cases in which galvanism was also used, and one of which proved fatal.

The experience of English Surgeons has been far less favourable. In the *Medical Times*, vol. ii. 1856, and vol. i. 1860, are to be found some valuable statistics of the cases which have been under treatment during late years in the metropolitan and provincial hospitals. Of the seventy cases included in the first report, which is believed by the reporter, Mr. Hutchinson, to be statistically accurate, as containing all the cases which had been under treatment, forty-six were popliteal aneurism, treated by pressure. The treatment succeeded in twenty-four of them. Of the remaining twenty-two, in whom the femoral artery was tied, two only died of gangrene; while of ten cases in which the artery was tied without preliminary compression, three died of gangrene. The period of treatment in the successful cases varied from sixty hours to eight months, nineteen days being the average time. The large proportion of cases in which pressure failed will strike the reader. It is probable that it was due to the novelty of the method; since in the second report, which contains fifty-nine cases, treated either by ligature or compression, the latter plan succeeded in twenty-five cases out of thirty-nine. Even this, however, shows a far less striking success than was at first augured for the method, and might have been expected from the experience of the Irish Surgeons. It is possible that a greater proportion of cures may be obtained as Surgeons become more acquainted with the method, and more alive to the necessity of attending to its minuter details. Meanwhile we may agree with Mr. Hutchinson's remark upon the above report, that all the success obtained by compression is clear and unbalanced gain; that in the cases which succeed, the patient is, with no appreciable danger to his life, withdrawn from the very serious risk of the Hunterian operation, and in those that fail the dangers of that operation are diminished.

The instruments required for the compression treatment are, one or two compressors, and a weight encased in leather. I shall describe the method as applied to the cure of popliteal aneurism; if the brachial or subclavian were the subject of compression, the modifications would be easily made. The compressors now in use are made on the principle of exerting pressure upon a small space, without any circular constriction of the limb. They consist of a plate, or trough, which is applied to the lower surface of the thigh at the point opposite to the artery, and a pad supported on this plate by a strong lever, or arm, and movable in all directions. The lever stands well away from the thigh, and the instrument is kept in position by the compression which it exercises. When applied, it is screwed down upon the artery until the sensation communicated by the aneurism to the hand is considerably lessened, say diminished about one-half; and is left so until the patient is sensible of inconvenience from it. It is by no means necessary to stop pulsation in the sac altogether, nay, it is not clear that this expedites the cure. Patients of quiet temperament and rather blunt sensibility can often tolerate for a time the degree of pressure necessary to stop the circulation; but it will generally be found that even in them it produces injurious consequences, either because the pressure acts on the vein as well as the artery and so causes œdema of the foot, or because the nerves become involved, or perhaps because the sac (which of course shrinks when most of the blood has passed out of it) becomes too violently distended on the withdrawal of the pressure, and so the process of coagulation is interrupted. It is better, then, to commence with very mild pressure, to change the place of its application frequently, and to give the patient such intervals of complete repose as may refresh his spirits and procure him good sleep. The management of the compressor should be intrusted to some one who knows the course of the artery, and can judge of the direction in which pressure should be applied to command it. The course of the artery can be indicated by a line drawn down the limb with caustic, and any intelligent patient or nurse soon learns where to apply the pad; but the application of pressure in the right direction is more difficult.* When the patient has got tired of the sensation caused by the pad of the compressor, he can lay the weight upon the femoral artery in the groin, raising it for a few minutes occasionally; or very often the patient prefers stopping the pulse by the pressure of the finger, thus combining digital with instrumental compression.

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* Want of space forbids a complete account of the various kinds of compressors which have been invented for the treatment of the popliteal and other forms of aneurism. Perhaps the best form, as obtaining the requisite degree of pressure with the least danger of producing a slough, and being, at the same time, least liable to slip, is Dr. Carte's apparatus, in which the arm carrying the pad is attached to the lever by means of india-rubber bands, and is movable in all directions on a ball-and-socket joint. It is very desirable, however, to have several instruments at hand, and to vary the point of pressure. The weight in the groin may be suspended by means of a string or wire, so as just to produce the necessary

The general treatment during compression is a point on which some variety of opinion exists. Some Surgeons, even in the present day, when stimulation is so much in vogue, prefer to adopt the depleting plan, although not to the extent recommended and practised by Valsalva; but the majority consider that the advantages, if any, derivable from this course, do not equal the difficulties which the restlessness, discomfort, and distress it occasions to the patient, throw in the way of the treatment. I have seen the depleting plan tried once, but it seemed quite inefficient, and the case was the most protracted cure by compression which I ever heard of; while, on the other hand, a sufficient diet and a moderate allowance of stimulants, if the patient has been accustomed to them, appears not to retard the cure, and certainly renders him more disposed to submit to it. Some Surgeons, acting on the idea thrown out by Dr. Stokes (see p. 366), prefer to feed the patient on a diet almost exclusively of meat, believing that the blood is thus made richer in fibrin, and more prone to coagulation. Opium is sometimes necessary to procure sleep; but if the patient be not of an irritable disposition, and the pressure has been commenced mildly, he can generally sleep quite well when the instruments are withdrawn; and cases occur occasionally where the patient can sleep undisturbed even while the compressor is applied.

The time required for the success of the compression treatment varies remarkably. In 26 successful cases, reported in the *Medical Times and Gazette*, the time varied from 60 hours to 8 months, the average being 19 days. In some of the protracted cases, the cause of delay has been the inefficient way in which the treatment has been carried out. Thus in the case of a young woman who was under Mr. Prescott Hewett's care in St. George's Hospital, on account of popliteal aneurism, some years ago, the disease remained stationary, notwithstanding the constant application of pressure for months, but was cured in a few days after her transference to the

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pressure without fatiguing the patient by holding it in his hand. Mr. Hart has contrived a plan by which the exact amount of pressure exercised is registered upon the compressor. This may be useful in preventing an excess of force from being unadvisedly employed. Much valuable information on these and other points connected with instrumental compression will be found in Tufnell's work on the subject.

care of a different nurse. It was discovered that the previous attendant had been in the habit of allowing her to remove the instrument and walk about the ward. In other cases, however, no such negligence can be detected, yet the cure makes no progress for a considerable time, when a favourable turn suddenly occurs, and the patient recovers rapidly. It seems impossible, with our present knowledge of the processes which go on in aneurismal sacs, to explain the reasons of these uncertainties; but the practical inference is, that as long as the tumour is not increasing, and the patient is not suffering from the treatment, it is reasonable and advisable to persevere. Auxiliaries to the treatment by compression may be sought in position of the limb and in direct pressure; but these methods must not be insisted on if they appear to cause distress, and thus endanger the success of the principal agent of treatment.

When compression succeeds, the case is precisely on the same footing anatomically as when the disease undergoes the process of spontaneous cure, so that the reader may be referred to what has been said upon that head in a previous paragraph. Sometimes the artery becomes thickened and contracted where the pressure was applied, and it is possible that it might become obliterated; but changes in the arterial walls are of rare occurrence, and take place probably only when compression has been exercised more vigorously and more continuously upon one spot than is either usual or desirable.* Usually when a limb is examined after the successful use of compression, the artery above the tumour shows no trace of its action. The tumour is generally quite firm, being filled with laminated coagulum; but sometimes a channel is seen, through which circulation has gone on in it. All this will be seen to be identical with the spontaneous cure. Enlarged anastomosing arteries are generally discovered, and this enlargement is usually and rightly regarded as one of the earliest and best symptoms of commencing cure.

The cure of aneurism by compression does not, however, always involve the obliteration of the sac, and does not, therefore, always involve the establishment of any new circulation. This point is illustrated by a preparation in St. George's Hospital museum,† in which a popliteal aneurism is preserved, which had been treated by compression of the femoral artery for more than two months. The sac lies between the artery and joint, and is entirely filled with laminated coagula, except a channel at the back continuous with the artery and forming a part of its tube. This method of cure is, however, not to be desired, since the clot may yield again to the force of the circulation,* and thus the disease may recur.

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* In *Med.-Chir. Trans.* vol. xliv. p. 189, will be found a case in which a varicose aneurism formed spontaneously at the part where pressure had been applied to the femoral artery many months before for the cure of aneurism.

† Series xi. subseries v. no. 23.

The failure of this method is due sometimes to the anatomical distribution of the arteries, as, for instance, when a vas aberrans carries on the circulation through the aneurism from a point above that which is compressed, and probably with more energy the more the main trunk is obstructed;† or it is due to sloughing of the skin under the pressure, to the patient's indocility or constitutional restlessness (by far the most frequent cause of failure), or to some deficiency in the tendency towards coagulation, which renders the blood in the sac incapable of going through the processes necessary to cure without a more complete interruption to the circulation than compression furnishes, and which must therefore be sought by ligature.

One great advantage, however, of the treatment by compression is, that when it fails it seldom fails totally; for if it does not succeed in curing the aneurism, yet in almost all cases it places the disease under more favourable conditions for cure. The obvious reason is, that it produces enlargement of the collateral vessels, and thus obviates the tendency to gangrene which is so decided in the lower extremity after the Hunterian operation upon the femoral artery. It seems highly probable, therefore, although at present the cases are far too few to form any conclusion, that the mortality from gangrene will be found much smaller in cases treated first by compression, and afterwards by ligature, than in those where the artery has been tied at the outset.‡

It might occur to the reader that this advantage will be in some respect balanced by the increased facility with which the blood would find its way into the artery above the sac, and thus carry on the circulation through it; but this does not seem to have been the case in any of the aneurisms so treated.

Compression, however, although it is usually harmless, if not beneficial, even in the cases where it is not entirely successful, is not always so. Cases do no doubt occur in which the aneurism increases with much greater rapidity after the application of the pressure, and goes on rapidly to bursting. In one such case the skin gave way, and the patient died of the hæmorrhage.*

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* See Mr. Spence's case, quoted on p. 426.

† The case marked 24 in Dr. Bellingham's table (*Med.-Chir. Trans.* vol. xxxiv. p. 149) is an example of this peculiarity.

‡ *Med. Times and Gaz.* Nov. 29, 1856.

As to pressure on the distal side of the sac, I have nothing to say, never having seen a case in which there was any temptation to use it. Its uncertainty and danger are so apparent, that it should never be used where compression or ligature can be applied above the tumour; but in aneurisms at the root of the neck, it may be in some cases worthy of a cautious trial.

T. HOLMES.

Digital Compression.

The treatment of aneurism by digital compression is of very recent origin. It has sprung directly from the successes, and, it must be said, also from the failures, of the treatment by mechanical compression. The first recorded case in which digital compression was successfully employed for aneurism appears to be that of a patient treated by Mr. Greatrex in May 1844, and whose case was recorded by that Surgeon in the *Medico-Chirurgical Transactions* for 1845. In this case the thumb or fingers were applied over the femoral artery in the intervals of compression by a tourniquet. The aneurism, which filled the popliteal space, solidified in twenty-four hours under this joint treatment by digital and instrumental compression. Two years later, Professor Jolliffe Tufnell,† treating a popliteal aneurism by compression with a tourniquet at the groin, found his progress impeded by enlargement of the inguinal glands, and taught his patient to compress the femoral artery with his thumb until the swelling of the glands subsided. In both these cases the pressure by the finger was employed as a temporary aid to instrumental compression, rather than as a means capable of effecting the cure of an aneurism.

But in 1848 Dr. Knight,‡ of Newhaven, United States, for the first time employed compression of the femoral by the fingers as the sole means of cure. The case was one of popliteal aneurism in a mulatto forty-eight years of age, for whom every kind of tourniquet and apparatus had been vainly employed. Before having recourse to ligature, Dr. Knight made trial of manual compression of the femoral; he obtained the help of a number of assistants, who relieved each other, two and two every half-hour, maintaining continued pressure to an extent which arrested pulsation in the tumour. At the end of forty hours the tumour was one-third smaller, hard, and pulseless. Compression was stopped, the cure was complete, and four months afterwards the tumour could hardly be felt. This success of Dr. Knight gave rise to other efforts in America. Mr. Fox,* in the Pennsylvania Hospital, applied digital compression to the treatment of an inguinal aneurism soon after the publication of Dr. Knight's case. He desisted from its employment, owing to the want of assistants, although much success had attended the trial. Mechanical compression was not well borne, and ultimately the external iliac was tied. His example was followed in the same year by Professor Willard Parker† and Dr. J. R. Wood,‡ of New York, who achieved successes in the treatment of femoral and popliteal aneurisms by the combination of digital and mechanical compression.

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* *Medical Times*, 1860, vol. i. p. 118.

† *Dublin Medical Press*, 1847, vol. i. p. 169.

‡ *Transactions of the American Medical Association*, 1848, p. 169.

During this interval the Dublin Surgeons had not published any case in which digital compression was employed. In 1852, Mr. Norgate§ recorded a case of popliteal aneurism, in which pressure by the thumb was temporarily employed in succession to mechanical compression. The tumour ruptured, and amputation was resorted to with success. And in 1854 Jameson|| obtained a cure by the mixed methods; he employed a Reid's compressor during six days ineffectually, introducing with successful effect six hours of digital compression. In another instance, Donohue, a patient of Mr. Colles's in the Meath Hospital, Dublin, observing that by compressing the femoral artery in tho groin he eased the pain of a diffused popliteal aneurism, quietly performed the compression during three days, so that when the Surgeon came to fit on a tourniquet he found that his patient had cured himself.¶

In Italy, Professor Vanzetti, of Padua, obtained, at this date (November 1853), a striking success in the treatment of popliteal aneurism by manual compression; his patient was a healthy man, aged nineteen, the subject of a right popliteal aneurism of the size of an orange, and of five months' duration. Methodical compression was made, by the hands of assistants, at the apex of Scarpa's triangle, and solidification of tho tumour was effected in forty-eight hours, without pain and without diminution of the temperature of the limb. In 1855 Professor Vanzetti treated a second case of

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* *American Journal of Medical Sciences*, 1849, vol. xxxvii. p. 377.

† Broca, p. 809.

‡ *Dublin Medical Press*, 1846, p. 150.

§ Ibid. 1852, vol. xxvi. p. 247.

|| Ibid. 1854.

¶ Ibid. May 1, 1854, p. 97.

popliteal aneurism, in the person of a young officer, by similar means, and with even more striking success. It was a spontaneous popliteal aneurism of two months' date; the knee was much bent. The patient himself was taught to compress the femoral artery during three weeks, and many times daily, each time from six to eight minutes; partial solidification followed. Methodical compression of the femoral artery, at the same point as in the former case, was then applied during five hours, with the effect of solidifying the tumour, and affording a complete cure. Professor Vanzetti, in recording these cases, mentions also that he applied the same method to the treatment of popliteal aneurism at the hospital of Karkof, in Russia, in 1846.* After two days, finding it unsuccessful, he passed at once to the ligature. It will be observed that, although unsuccessful and not published until 1858, this was the first attempt at curing an aneurism by manual compression solely; just as Dr. Knight's case, in 1848, previously mentioned, was the first instance of a cure actually effected by the sole use of pressure by the hand. Hence Professor Vanzetti claims a priority as inventor of digital compression, which has commonly been accorded to Dr. Knight.† The merit of strongly insisting upon the value of digital compression, and studying its applications to surgical treatment with a success which fixed the attention of European Surgeons, is undoubtedly due to Vanzetti. These early successes were speedily followed by others equally remarkable. In July 1856, a female patient came under the care of Professor Gioppi,‡ of Padua, the subject of aneurism of the ophthalmic artery; the case was one of great severity. I have before me the portrait of the patient, which fully confirms the written descriptions: the eye projected on to the cheek, it was motionless; the cornea was infiltrated and opaque; the sight was gone. The pulsating aneurismal tumour could be felt by introducing the finger between the globe of the eye and the roof of the orbit; the bruit could be heard loudly. The carotid was compressed for periods of a minute or two, and, with frequent intervals, by the convalescents of the ward and by the patient herself. Pressure continued for more than a minute produced fainting. Nevertheless, at the end of one day there was a visible improvement, and at the end of four days all pulsations had ceased. Four months afterwards the eye rested and moved naturally in the orbit; vision was restored, the patient remaining only somewhat short-sighted, and with the pupil slightly dilated. A second case, in which a formidable aneurism of the ophthalmic artery, in a patient the subject of aortic and cardiac disease, was cured by digital compression, was published, in 1858, by Drs. Vanzetti and Scaramuzza.* Intermittent compression of the carotid by the finger was here also employed for five minutes at a time, and cure was effected by seven hours and twenty minutes of compression spread over eighteen days. These brilliant successes, real triumphs of conservative Surgery, supported as they were by abundant and irrefragable testimony, sufficed to place digital compression amongst the most precious resources of Surgery in the treatment of external aneurism.

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* *Annali Universali di Medicina*, Milano, Gennajo, 1858.

† *Priorità del Metodo di curare gli Aneurismi colla sola mano, dovuta alla Scuola di Chirurgia dell' Università di Padova, del Prof. Tito Vanzetti;* Annali Universali, vol. clxiii. p. 667.

‡ *Annales d'Oculistique*, 1857.

The subsequent experience of Surgeons who have employed this treatment since Vanzetti, affords numerous instances of cure unrivalled for simplicity, painlessness, ease, and rapidity in the records of the treatment of aneurism by any other means. Thus, M. Michaux, of Louvain, recorded, in 1857, two cases of popliteal aneurism cured respectively by 113 hours of intermittent compression (during eight days), and forty-four hours continued compression; whilst he cured a large femoral aneurism by forty-eight hours of digital compression.† Other Surgeons have had similar success. In nineteen cases successfully treated by digital pressure, the average number of hours of pressure was not more than forty-one and a half, spread, however, over a variable period of time, owing to intermissions of the pressure. According to the most favourable reports of those who are greatly interested in the treatment by mechanical compression, the average duration of treatment by that method stands at twenty and a quarter days for each case.

It has been objected to the digital mode of treatment, that, from the considerable number of assistants required, it could only be carried out in certain large hospitals, and then at great inconvenience. This objection is, however, of no great force; for, under such circumstances, assistants are rarely wanting, and in more than one case the patient has been able successfully to complete the cure by the unaided pressure of his own fingers. And although a full staff of eight or ten assistants are sometimes required, yet a smaller num-

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* *Secondo Caso di Aneurisma dell' Arteria ottalmica guarito colla compressione digitale della carotide*, &c., del Dott. T. Vanzetti, &c. &c., Padova, 1858.

† *Bulletin de l'Académie de Médecine Belge*, series ii. vol. i. no. 4.

er will often suffice. Most Surgeons are, I think, agreed that the
ressure should, as a rule, be intermittent. The opposite practice
roduces occasionally some rapid and brilliant cures; but it tends to
rocure coagulation *en masse* of the contents of the aneurismal sac
ith its accompanying dangers, while the intermittent treatment
avours the safer form of laminated fibrinous deposition.

The application of the finger to the cure of aneurism by indirect
ressure has already yielded admirable results; and it is probable
at it will continue to meet with increasing favour among Sur-
eons. Not only are the cures thus effected often rapid and com-
aratively painless, but the method may be applied to arteries,
ch as the carotid and the facial, which are not easily accessible to
ny form of mechanical pressure.

ERNEST HART.

Treatment by Flexion.

The simple bandaging of the limb in acute flexion, the patient
eing kept at rest, may occasionally succeed in curing aneurisms
tuated at the bend of the limb, as in the popliteal space or the
bow, and possibly in the groin. This plan of cure had been pre-
iously tried; but the merit of first demonstrating its success is fairly
e to Mr. Ernest Hart.* All that is requisite in this treatment is
bandage the limb from the toes nearly to the knee with a roller,
d then to turn the roller round the thigh flexed at an acute
gle; the limb should then be bent upon the pelvis, and the knee
sted against a pillow. In Mr. Hart's case, the cure had made
nsiderable advance after the first day of the treatment, and was
mplete on the fourth day; on the seventh the patient was moving
out. In Mr. Shaw's case, the cure was much more protracted,
d the cessation of pulsation was not reported till the thirty-eighth
y; but then the tumour was larger. In neither of these cases
as any rigorous system of diet enforced, nor did the patient com-
ain of the least inconvenience in either. Several other successful
ses have been put on record. The most interesting and im-

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* For the details of this case, which I had the opportunity of seeing, in
nsultation with Mr. Hart, before the commencement of the treatment,
e *Med.-Chir. Trans.* vol. xlii. p. 205. In the same volume is the report of
similar successful case under the care of Mr. Shaw. The plan is under-
od to have been tried some time ago on a patient of Mr. Fergusson's at
ng's College Hospital; but it seems likely that the trial was not very per-
tent. The details have been lost; and the fact was first mentioned after
e publication of Mr. Hart's case.

portant of these, in which genuflexion succeeded after the failure of the Hunterian operation, and of instrumental compression on the femoral artery, is reported by Mr. Spence in the *Edinburgh Medical Journal* for November 1859, p. 434. The patient had applied for advice originally in May 1857 on account of an aneurism, which had only been noticed a month, and which increased so rapidly while he was under observation, that the femoral was tied below the origin of the profunda without further delay. There was some apprehension of gangrene after the operation, showing apparently that the circulation was reëstablished only slowly. The ligature separated on the twenty-ninth day, and then some undulatory pulsation was noticed in the tumour, which, however, was much diminished in size. By bandaging the limb, cautious compression of the femoral artery, and direct pressure by a compress of lint over the tumour, this pulsation was reduced to a line corresponding to the course of the artery, and not larger than the popliteal on the other side. The patient was then discharged, and returned to his avocation, that of a coal-carter. In August 1858 he came to the hospital again, as the tumour had suddenly increased within two or three days. It was then found to be as large, and pulsating as violently, as before the artery was tied. Compression was tried, and persisted in for five months, but the tumour increased instead of diminishing. It was then proposed to tie the femoral artery low down, *i. e.* in Hunter's canal, since the upper part of the superficial femoral appeared obliterated. Previous to this, however, it was thought right to give a trial to the flexion treatment; and this succeeded so well, that in a week the pulsation had very much diminished, and in a month the aneurism was quite cured, its contents being perfectly solid, and the anastomosing vessels enlarged. The man again returned to his laborious avocation, and was presented to the Medico-Chirurgical Society of Edinburgh four months afterwards; the cure being quite complete.*

It ought to be noticed here that this man could not at first bear the complete flexion of the limb; accordingly a slipper, with a piece of bandage sewn to the heel, was fastened on the foot, and the bandage was then attached to a loop connected with a broad band round his pelvis, and this loop was gradually tightened, so as to increase daily the flexion of the leg on the thigh. The confinement to bed appears to have lasted little more than a fortnight. This milder plan of employing flexion may be often found successful when the patient cannot tolerate more rigid confinement.

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* A second case under Mr. Hart's care has been recently communicated to the Royal Medical and Chirurgical Society, in which the cure was effected in a few days without even confinement to the recumbent position. See an abstract of Mr. Hart's paper in the *Lancet* for Feb. 8, 1862.

Many cases are also reported in which flexion has been successfully used in combination with pressure. In one under the care of Mr. Pemberton,* the amount of pressure used was so slight that no great importance is attached by him to its action. Yet the aneurism, a large one, and pulsating strongly, was cured in less than twelve hours. A somewhat similar case is reported by Mr. A. Pritchard, of Bristol, in the *British Medical Journal*, March 30th, 1861.†

The failures which have hitherto been recorded appear not beyond what any other method of treatment is exposed to. Thus in Mr. Moore's case above referred to (p. 411), flexion was tried unsuccessfully; but then the tumour was large, and was growing rapidly towards the joint; and such cases are peculiarly intractable. In a case under Mr. Paget's care,‡ this method was tried, and failed; but in that case other methods of treatment also failed, the case not being one of aneurism in the proper sense of the term, but of ulcerated artery without a sac.

The cases best adapted for the trial of flexion are the simplest. In those cases where the tumour is not of very large size, where the parts covering it are not much inflamed, nor the joint involved, and where, as far as can be ascertained, the tumour is seated on the superficial face of the artery, we may anticipate benefit from flexion. If the flexion of the limb entirely, or almost entirely, suspends the pulsation and the bruit, this treatment may be trusted by itself; otherwise a compressor must be applied to the artery above in aid of the flexion. But the compression need not, in such a case, be applied with nearly the same severity which would be demanded in an ordinary case.‖ A very slight amount of pressure will often serve; and if the only advantage of this simple and nearly painless proceeding were to spare the patient the annoyance of severe pressure, it would be no slight one. There are, however, many cases in which the aneurism will be entirely cured by it, without the smallest risk either to life or limb.

T. HOLMES.

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* *Lancet*, Sept. 3, 1859, p. 232.

† See also a case by Mr. Colles, in the *Dublin Hospital Gazette*, June 15, 1860; and one by Dr. Leith Adams, *Med. Times and Gazette*, Jan. 26, 1861.

‡ *Medical Times and Gazette*, 1859, vol. ii. p. 505.

‖ See Mr. Pemberton's case above referred to.

TREATMENT BY MANIPULATION.

A method of treatment has been founded upon the consideration of the pathological changes which by the deposition of fibrin and occlusion of the cavity of an aneurismal sac lead to its cure, and the analysis of certain cases in which the accidental displacement of clot from within the sac, and its impaction in the artery in the distal side of the aneurism, has seemed to give rise to exceptional cures. Mr. Fergusson has endeavoured artificially to imitate this process by means of a particular manipulation of an aneurism, whereby the fibrin within may be so displaced as, either in part or in whole, to block up the main artery on the distal side of the disease. In a paper, which will be found in the *Medico-Chirurgical Transactions*, vol. xl. p. 1, that Surgeon describes two cases which he submitted to this treatment. Both were cases of subclavian aneurism. The first patient was a healthy-looking man of middle age, having a large aneurism of two years' standing, involving chiefly the middle part of the artery. In the event of any operation by ligature having been determined on, the vessel must have been tied either on the tracheal side of the scalenus, according to the Hunterian method, or on the distal side, according to the method of Wardrop or Brasdor. Mr. Fergusson thus describes his proceeding: "The patient was seated in a chair; and I placed the flat end of the thumb on the aneurismal tumour so as to cover the prominence. I then pressed, until all the fluid blood had passed from the sac, and I could feel that the upper side of the aneurism was pressed against the lower. I now gave a rubbing motion to the thumb, and felt a friction of surfaces within the flattened mass. The movements were little more than momentary, but they were such as I had preconceived." The immediate effect was to produce giddiness and mental confusion, so that the patient was for a time unable to stand. Pulsation ceased in the arteries below the tumour, and pain was experienced in the hand and fore-arm. In the evening, however, pulsation had returned in these vessels. Next day the manipulation in the way described was repeated, with much the same immediate effects. Pulsation returned slowly after some days in the arm and hand. The tumour was considered manifestly less and to pulsate less strongly. It never ceased, however, to pulsate; and eight months after, the patient died, owing to rupture of the sac at the lower and back part. It was found to contain solid fibrin of old date, and recently coagulated blood. The axillary artery was filled with a firm plug of fibrin. In the second case so treated by Mr. Fergusson, paralysis of the left side of the face and of the left fore-arm and leg followed the first manipulation, the pulse ceasing at the wrist. With this exception there was little material change. At the end of two months the patient resumed his occupation as a seaman, having regained the use of his left side; but the tumour being apparently unaltered. A year after, he was again seen, and an attempt made to keep up continued pressure on the tumour; but it proved so unsatisfactory, that it was given up. Again, at the end of the year, that is, two years after the first employment of manipulation, he returned; and now the tumour had completely disappeared, there was not a trace of it to be perceived; a slight pulse could be felt at the wrist. The arm seemed much the same as its fellow, and in the left side paralysis had gone off.

Neither of these cases afforded satisfactory evidence of the efficacy or safety of this mode of treatment. In the first case, although the tumour was considered to be somewhat solidified, it never ceased to pulsate; and after a few months caused the death of the patient by bursting. In the second case no perceptible effect was produced on the tumour at the time, nor did it seem to be much changed at the end of a year; but after two years of laborious occupation, the tumour was found to have disappeared. It must be considered doubtful how far this result was due to spontaneous changes, or to accidental displacement of the contents of the tumour in the course of the patient's frequent exertions.

The sudden faintness of both these patients immediately after the manipulation of the tumours, and the paralysis which followed in the second case, indicated sources of danger connected with this treatment, which Mr. Fergusson did not omit to point out. It seemed possible that in the manipulation some of the broken-down fibrin was squeezed towards the mouth of the vertebral or carotid arteries, and by obstructing the flow of blood to the brain produced hemiplegia in the manner suggested by Dr. Kirkes, who, in a paper read before the Medical and Chirurgical Society in May 1852, pointed out the probability of this condition being produced by fibrin from the valves of the aorta being carried along mechanically in the blood. A case highly illustrative of this danger has since been described by Prof. Esmarch.* Capt. C. H. consulted a friend of Prof. Esmarch's for tonsillitis, and at the same time drew his attention to a tumour on the left side of his neck, which had formed suddenly three years previously, without appreciable cause, and had now attained the size of a hen's egg. It was easily diagnosed as an aneurism of the common carotid. On repeating the examination a few days later, and exerting pressure upon the tumour for the purpose of reducing it, the patient fell suddenly back with symptoms of apoplexy; he was at once bled, and conveyed to the hospital, where he was placed under the care of Dr. Esmarch. There was right-sided cerebral paralysis; the pupils were dilated, but reacted to the light; the tumour pulsated isochronally with the carotids, but presented no murmurs. Prof. Esmarch diagnosed the detachment of fibrin from the aneurismal sac, and consequent obliteration of the left carotid. Death ensued three days afterwards. At the autopsy, performed by Prof. Weber, of which the most careful details are given, the sac of the large aneurism was found to be partly lined with more or less firmly attached, ragged, fibrinous coagula; much loose fibrin irregularly interwoven was also in the sac; a firm coagulum was drawn out of the internal carotid, and this coagulum was found to extend up to the carotid foramen. There was no coagulum in the external carotid. The cerebral carotid, the middle cerebral, and the ophthalmic artery were completely blocked up with coagula of a dark-brown colour, enclosing numerous red and grayish-white plugs, which evidently were derived from the aneurism. Their identity was proved by the microscope. There was considerable softening of the middle of the left hemisphere, including the corpus callosum.

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* Virchow, *Archiv für Path. Anat. und Physiologie*, vol. xi. p. 410, 1857.

A somewhat similar accident was described by Mr. Teale of Leeds, in some clinical remarks delivered in 1859.* He mentions that in the year 1847 he was one of a numerous consultation in a doubtful case of carotid aneurism. The subject of it was a middle-aged female, in good health in other respects. She was seated in a chair while the tumour was examined by several persons in succession, and subjected by them to repeated handling and compression. While this was going on, she suddenly became pale and slipped off the chair. On being raised, she was found to be hemiplegic; after lingering in this state a few weeks, she died. The tumour was found after death to be aneurismal. These two cases serve to show very strongly the dangers which, as Mr. Fergusson himself pointed out, are likely to follow the manipulation of aneurismal tumours of the neck. On the other hand, subclavian aneurisms are almost always ultimately fatal, and have never yet been successfully treated by the Hunterian ligature. Soon after the publication of Mr. Fergusson's paper, Mr. Robert Little[*] admitted into the Donegal Infirmary an Albino, aged fifty-three, having an aneurism of the right subclavian artery, of nine months' duration, of considerable size, pulsating strongly, having a loud bruit, soft and compressible, somewhat red and inflamed on the cutaneous surface. Anodynes, sedatives, local refrigerants, and venesection were employed without effect. On the first of January 1856, by making gentle but steady pressure with the thumbs alternately over the aneurismal sac, Mr. Little succeeded in displacing some of the coagula, and directing them towards the distal opening of the artery. No other local treatment was adopted; but the patient was ordered a preparation of iron internally. For the first two days no change was perceptible either in the tumour or the arm; but on the third day the pulse at the wrist was manifestly weaker, and the arm somewhat colder than the opposite one. These symptoms gradually increased up to the tenth day after the manipulation of the sac, when no pulsation could be felt in either the radial, brachial, or axillary arteries. From this time the tumour itself gradually became more solid, and finally all pulsation ceased. The tumour wasted to the size of a small walnut, and two superficial arterial branches could be traced running transversely across it; one immediately above the clavicle, the other somewhat higher up. For a time the arm was partially paralysed and very cold, but it subsequently recovered sensation and motion; and when the patient was seen a year afterwards, his cure was in all respects satisfactory and complete.

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* *Med. Times and Gaz.*, March 1859, p. 265.

In addition to this highly satisfactory and interesting cure, Mr. Teale of Leeds, and Dr. G. E. Blackman of Cincinnati, have each successfully treated an aneurism of the lower extremity by manipulation. Dr. Blackman[†] received under his care, in April 1857, a man, the subject of a large femoral aneurism, measuring five inches at the base. After forcibly manipulating the tumour with the view of dislodging the fibrinous contents, a Skey's tourniquet was applied to the femoral artery immediately below Poupart's ligament. Much pain was complained of in the tumour, and the pulse rose to one hundred and ten, being full and strong. The patient was bled to nine ounces, with the effect of diminishing the pain and bringing the pulse to fifty, soft and regular. After four days the tourniquet was taken off, the leg was bandaged, and as the pulse was still high, venesection was again employed, and opium and tartarised antimony administered internally. On the tenth day pulsation had altogether ceased. The cure remained good. The femoral artery is described as being plugged as far as the origin of the profunda, while in the popliteal space the pulsation of the artery was hardly perceptible. It is not, however, very easy in this instance precisely to define the respective effects of the treatment by compression and that by manipulation, although the latter may be considered to have played an important part in producing the cure. In the case treated by Mr. Teale, compression of the femoral at the groin had been employed for some days, in the treatment of a popliteal aneurism, with the effect of producing some deposition of fibrin in the sac and enlargement of collateral vessels; but no material improvement having been effected, Mr. Teale attempted to produce displacement of the fibrin in the sac by moderate manipulation. The first attempt excited little change; he then repeated the manipulation with greater freedom, "kneading the tumour in various directions." An hour and a half after the last manipulation, the tumour had entirely ceased to pulsate, and had become a solid mass. Eleven days subsequently, the patient left the hospital cured, the tumour having decreased rapidly in size, and he having been able to walk about the ward a few days.* From the data furnished by these cases, which are the only ones yet published bearing on this mode of treatment, a judgment may be formed of the uses and dangers of the ingenious but somewhat hazardous practice of manipulation in the treatment of aneurisms.

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[*] *Med. Times and Gaz.*, May 23, 1857.

[†] *Western Lancet*, June 1857; *New York Journal of Medical Science*, 1857, p. 291.

TREATMENT BY GALVANO-PUNCTURE.

In the preceding modes of treatment of aneurism, it is proposed to effect a cure either by retarding the course of the blood, or by introducing elements which favour the precipitation of its plastic principle. Galvano-puncture aims at producing such a modification of the contents of the sac as shall favour slow coagulation, without incurring the risk of introducing into the circulation foreign and perhaps injurious matters. This end it occasionally accomplishes; but it is not without its own peculiar accidents and dangers. Thus out of fifty cases of aneurism so treated, collected by Ciniselli,† twenty-three were cured, twenty were not cured, and in seven instances death resulted. Indeed the first applications of electro-puncture made by Benjamin Phillips,* Liston, and Gérard, in 1838, and the subsequent essays of Mr. Keate,† were so little successful as to discourage further trials; and but for M. Pétrequin,‡ whose persevering application of this plan was, in 1845, followed by success, the procedure might not yet have found a place in practical Surgery. Since the publication of those cases, repeated applications have been made by Surgeons of every school and to all kinds of aneurism. But although these have served to show clearly the power of electricity to effect the cure of aneurisms, they have shown also very clearly the danger and accidents to which it may give rise. It is a radical defect of this procedure that it acts by inducing direct (or "passive") coagulation of the blood in the sac. Hence it is inherently uncertain, liable to cause relapse by the melting of the coagulum, or inflammation by its too sudden deposition.

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* *Med. Times and Gaz.* p. 265, March 1859.

† *Sulla Elettropuntura nella cura degli Aneurismi*, by Dr. L. Ciniselli: Cremona, 1856.

Again, it is very capable of exciting inflammation in the walls and contents of the sac. Then too the needles sometimes produce eschars at the points of their insertion, and thus give rise to consecutive hæmorrhage. So that in forty-three cases which have been tabulated, it is stated that thirteen have been the subject of grave accidents, and the remaining thirty of slight accidents. In fact the cases are few in which a perfectly happy result has been obtained; but some of these are worthy of particular attention. Thus a subclavian aneurism, forming a tumour as large as a hen's egg beyond the clavicle, was cured by this method by Dr. Abeille.§ The success of this case alone, the size of the vessel affected, its proximity to the heart, the rapid increase of the tumour, and the coincidence of constitutional disease, would suffice to give importance to the method by which it was cured. Again, the successful application of galvano-puncture by Nélaton to cirsoid aneurism,‖ and to varicose aneurism at the elbow by Voillemier, afford instances of success in the treatment of varieties of the disease not very amenable to other modes of treatment. Two cases are recorded in which galvano-puncture has been employed in the treatment of aneurism of the ascending aorta; once quite ineffectually, and once with the result of producing what is described as "a very sensible and evident improvement."*

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* *Experiments showing that Arteries may be obliterated without Ligature.* See the work of Phillips, London, 1832; and his Letter claiming priority of invention, in the *Archives gén. de Méd.* 1847.

† *Lancet*, 1837-8, vol. ii. p. 668.

‡ *Comté-rendu de l'Acad. des Sciences*, 1845, vol. xxi.

§ *Archives gén. de Méd.* Aug. 1849.

‖ See infr. Cirsoid Aneurism.

From the study of numerous collected cases, it may be seen that the modus operandi of galvano-puncture in cases where cure has followed its application, has not always been identical. In some instances, the introduction of the needles into the sac and the application of the current has apparently been followed by the formation of a clot which only partially filled the aneurismal sac; and by virtue of the power which freshly deposited fibrin has of attracting to itself fresh layers of fibrin from the circulating blood, the clot has gradually increased in size, until the tumour was solidified and cure effected. This is the most favourable sequence, and may be regarded as the typical result. But this sequence is rare. In other cases, at the end of the sitting the sac is already filled with a more or less solid coagulum; sometimes this melts, sometimes it remains permanent and yields a cure. Most commonly, however, the introduction of the needles has been followed by symptoms of inflammation within the sac, and the cure has been due to the effect of this inflammation. Either coagulation has slowly followed upon the inflammatory action, or suppuration and obliteration of the sac has been induced. The pain of the operation is in all cases very considerable.

All these methods of cure must be considered as less satisfactory than those in which deposition of stratified fibrin is slowly obtained. The peril and the uncertainty which attends every method of treatment aiming at the cure of aneurism by the formation of passive or direct clots, must place it in the second grade. The risk of exciting inflammation in the sac and its contents is a very serious hazard, and the statistics of this method practically confirm the objections which we may adduce simply from a knowledge of its mode of operation.

Galvano-puncture appears, then, at present to deserve to rank only as an exceptional expedient. Its claims will have to be considered by the practical Surgeon principally when he is called upon to treat either aneurisms at the root of the neck, or internal aneurisms which cannot be reached by digital or mechanical compression, and some forms of varicose and cirsoid aneurism seated superficially. The dangers and imperfections of the process must restrict its application even in this limited field. But as a resource, available in cases where neither compression nor ligature can be advantageously applied, it has a sphere of useful action.

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* *Gaz. Medica di Milano*, 1847, no. 2; ibid. 1850, no. 33; *Gaz. Medica Ital. Lombard.* 1850, no. 44.

Treatment by Coagulating Injections.

The treatment of aneurism by the injection of coagulating fluids into the sac, with the view of inducing the formation of a solid clot, was first proposed by Monteggia.[*] He recommended that they should be injected by a trocar; he suggested alcohol, acetate of lead, and tannin, as coagulating agents; and thought that their use might be combined with that of Brasdor's ligature or indirect compression. This idea of Monteggia was broached again by M. Vilardebo,[†] M. Leroy d'Etiolles,[‡] Wardrop,[§] Pravaz, and Pétrequin.[||] Wardrop had recommended acetic acid as a coagulating medium, advising also the stasis of the blood in the tumour by compression above and below. Pravaz, struck by the energetic coagulative action of perchloride of iron on the blood, made some striking experiments on the subject, which were communicated to the French Society of Surgery by Lallemand, in 1853. Injection of this fluid was immediately applied successfully to an aneurism of the supra-orbital artery by M. Raoult Deslongchamps. Since that time it has been employed in a considerable number of cases, of which upwards of thirty have been collected. No doubt can now exist of the powerful action of styptic injections into aneurismal sacs, and especially of the power of the tincture of sesquichloride of iron, introduced by Pravaz; but experience has shown that the dangers of this proceeding are considerable, and its applicability limited. The accidents which have been found to follow the injection of perchloride into the aneurismal sacs have been: 1. *Inflammation and suppuration of the tract of puncture.* This occurs especially when, in withdrawing the canula after injection, a drop of the perchloride which hangs about its extremity comes in contact with the tissues; a serious, but preventable, accident. 2. *Peri-arterial abscess.* This may occur either from the extravasation of the injection around the sac, owing to a defect in manipulation, or from the propagation of inflammatory action from the walls of the sac to the surrounding cellular tissue. 3. *Inflammation of the sac.* This is the most serious and the most common accident following the injection of the perchloride of iron. All coagulating injections act by rapidly producing a passive clot. This of itself is a well-known cause of inflammation of the sac. Moreover the perchloride is a highly irritating fluid, which not only produces rapid coagulation of the blood, but has the effect of causing inflammation in all the tissues with which it comes in contact. Hence the immediate effect of the injection in a number of cases has been to excite inflammation, more or less intense, followed by, 5. *Abscess of the sac;* 6. *Gangrene of the sac;* 7. *Rupture;* 8. *Hæmorrhage;* 9. *Gangrene of the limb.* In eighteen collected cases, the injection proved fatal four times; twice from gangrene of the limb, once from hæmorrhage following gangrene of the sac, and once from phlebitis. This is a formidable roll of accidents and a large proportion of deaths. It will seem yet larger when we remember, that it is a condition of primary necessity now recognised by all Surgeons, that before the method of injection can be applied, it must be possible to arrest the current of the blood by pressure on the artery above and below the tumour. Thus it would be possible in nearly all these cases to apply either instrumental or digital compression or flexion; proceedings which can count a larger proportion of successes, and which are not open to the same objections.

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[*] *Instituzioni Chirurgiche,* Milan, 1813, 2d edit. pp. 68, 82, 124.

[†] *De l'Opération de l'Anévrysme,* p. 102, Thèses de Paris, 1831.

[‡] *Recueil de Lettres et de Mémoires,* 1844, p. 276.

[§] Costello's *Cyclop. of Practical Surgery,* vol. i. p. 218, London, 1841.

[||] *Bulletin de la Société de Chir.* vol. iii. p. 524.

The treatment by injection has been applied to nearly every form of external aneurism: to popliteal aneurism, by Niepce, Lenoir, Minor, and Isaacs; to carotid aneurism, by Dufour; to aneurisms of the elbow, by Jobert, Serres d'Alais, Vallette, and Dieulafoy; and even to aneurisms of the innominate, by Barrier; of the subclavian, by Pétrequin; and of the aorta, by Syme. The last three varieties are totally out of the domain of this method of treatment, because they are inaccessible to the compression of the artery on their cardiac and distal side; and without this precaution the small clots formed by each drop of the perchloride on its entering the sac, are capable, as has been proved by experience, of being carried by the blood into the ramifications of the artery and producing gangrene. To repeat those experiments would, therefore, now be rash. Aneurisms of the popliteal artery, and of the extremities generally, are susceptible of such satisfactory treatment by compression and flexion, that the more dangerous method of injection would here be out of place. An exception, however, must be made for those varicose aneurisms seen most commonly at the elbow after venesection, which have not always proved amenable even to digital compression, and in which deligation is somewhat complicated and difficult. Injection of perchloride of iron has four times been successfully applied to such a condition by Jobert, Serres, Vallette, and Dieulafoy; and proper precautions being used, this method may here be found advantageous. The same may also be said for cirsoid and anastomotic aneurism. (See Cirsoid Aneurism.)

When in any case it is determined to inject a coagulating fluid, it is desirable to adopt certain precautions. In the first place, as to the fluid selected. Various preparations of iron, such as the lactate, the persulphate, the acetate of the sesquioxide of iron, tannic acid, alcohol, and acetic acid, have been recommended and employed; but the coagulating power of the solution of the perchloride is so much greater than that of any of these fluids, that it obtains the preference, notwithstanding its irritating qualities. In order to reduce this irritating action to its minimum, it is desirable to employ a neutral solution of the perchloride and one of feeble dilution. Very careful directions have been given for the preparation of the solutions by M. Burin-Dubuisson,* M. Soubeiran,† and others. In the earliest cases a solution was employed of the strength of 45°-49° Beaumé, *i. e.* sp. gr. 1·454-1·526; but experience has shown that solutions of this strength are productive of excessive inflammation, and lead almost inevitably to grave accidents. The experience of M. Vallette has shown that a solution of 20° Beaumé possesses great coagulating power, and no higher degree of strength should be employed. Care also should be taken not to inject an excess of the perchloride; for this not only inflames the tissues of the sac, but diminishes the solidity of the clot. M. Broca advises the injection of twenty drops to every centilitre (·100th of a pint) of the contents of the aneurismal sac. The recent experience of M. Dieulafoy (1859) seems to show that one-tenth of this quantity may suffice; and that for an aneurism containing twelve centilitres or 3½ozs., eighteen to twenty drops only need be injected. The best instrument for the purpose is the small graduated syringe with screw piston and glass body, made for the purpose by most instrument-makers, and also used for subcutaneous injections. In performing the injection, it is necessary first to establish accurate compression of the artery above and below the tumour, so as completely to arrest the blood in it. The pointed trocar is plunged perpendicularly into the tumour, care being taken on the one hand to enter the cavity, and on the other not to transfix it; both of which accidents have happened to experienced operators, and are productive of obvious inconvenience. The success of the step is indicated by the issue of *arterial* blood, an indication which should be looked for. The canula is now screwed on to the trocar, and so much of its contents as may be thought necessary ejected by successive turns of the piston. Each turn is usually equivalent to half a drop, and the quantity injected may be further estimated by a reference to a scale, which should be marked on the glass body of the syringe. The point of the trocar may be directed upwards, downwards, and on either side, without withdrawing it, so as to form several centres of coagulation. When the tumour has acquired a certain consistence and the coagulation has sufficiently taken place, one turn backwards should be given to the piston, so as to draw up the liquid contained in the canula and to prevent its irritating contact with the tissues; it is then carefully withdrawn. The compression of the artery on the cardiac side of the sac should be continued for an hour.

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* *Compte-rendu de l'Acad. des Sciences*, 16th Jan. 1854, vol. xxxviii. p. 89.

† *Bulletin de Thérapeutique*, vol. xlv. p. 454, 1853; see also *Thèse de M. Jean Pravaz*, Paris, 1857.

It is necessary to attend to these precautions very carefully, because experience has shown that owing to their neglect many of those serious accidents occurred which marred the success of the earlier series of cases. Notwithstanding their observance, it is to be expected that inflammation of the sac, with its attending disasters, will frequently follow the injection of the perchloride of iron; and since this method is mainly applicable to those superficial aneurisms which can be treated by other proceedings not open to that objection, and not followed by those dangers, the applications of the treatment by injection are likely to be limited. The discovery of a fluid of great coagulating power, and devoid of irritating properties, is a desideratum in this method.

ERNEST HART.

Traumatic Aneurism.

By 'traumatic aneurism' is meant a tumour containing blood, communicating with the cavity of an artery, and due to a wound of the vessel. Three descriptions of injury may lead to the formation of a traumatic aneurism: 1. a wound penetrating from the surface; 2. a tearing or strain of the coats of the vessel without wound; 3. fracture of a neighbouring bone.

The first is the most common, or at least the most commonly recognised* cause of traumatic aneurism. A man receives a stab or a small incised wound. It bleeds freely, and most likely in jets; but the hæmorrhage is restrained by firm pressure; the wound heals, and the man thinks himself cured. He is conscious, however, of some loss of power and some anomalous sensations in the limb, such as cold, numbness, tingling, and a feeling of weight; and later on he discovers that a pulsating tumour exists beneath the scar of the wound.

In such a simple case it is easy to see what has happened: the artery has been penetrated by a wound which was too large to be closed by the mere efforts of nature,† but which did not cut the tube across, and did not stop the circulation. The blood has not had a very direct exit by the skin-wound, probably in consequence of the altered position which fasciæ and other membranous structures assume in deep wounds, under varying conditions of pressure, tension, &c., and therefore the bleeding has not interfered with the healing of the opening in the skin. Meanwhile, below the fascia blood has continued to exude into the cellular tissue among the muscles, forming a large diffused ecchymosis. This ecchymosis may continue for some time to increase; such, however, is not necessarily the case, since as much of the blood may be withdrawn from the cellular tissue by the action of the absorbent vessels (the veins, and possibly the lymphatics), and by reflux into the artery during its diastole, as is poured out during the systole. Sooner or later, however, the presence of the blood acts as a source of irritation, and sets up inflammation in its neighbourhood. This causes condensation, and then contraction of the areolar tissue, and so a sac is formed. By this time, probably, a great part of the blood has coagulated, and so the aneurism (as it now is) contains a mixture of clotted and fluid blood, as most aneurisms do. The case now differs in no respect from one of spontaneous aneurism, except, perhaps, in its greater proneness to cure, since the heart and arteries are probably healthy; while in many cases at any rate of spontaneous aneurism they are diseased.

The symptoms of this kind of traumatic aneurism are generally distinct enough. The scar of the wound will be discovered even if the history is obscure, and the pulsation and bruit are generally distinct. But it must not be forgotten, that before the sac has been formed, pulsation is often indistinguishable, though the bruit can almost always be recognised. Such lesions as these are often incorrectly spoken of as 'aneurisms;' a term which is only applicable when the sac has formed. This is not a theoretical or pedantic verbal distinction, but a practical difference of the greatest importance. The formation of a sac is the first step towards the cure of the disease, and shows that the case is amenable to the comparatively mild and indirect measures which are adequate for the cure of an aneurism, such as pressure on the main trunk, or its ligature at a convenient spot above the tumour, instead of requiring the frequently severe and difficult operation necessary for exposing and securing the wounded part of the vessel.

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* If we consider the frequency with which popliteal and other surgical aneurisms are attributed to accident, and their much more frequent occurrence in persons and in situations most exposed to violence, we might be tempted to conclude that such aneurisms are usually traumatic, and due to the second of the class of causes above enumerated.

† See vol. i. pp. 682, 686.

The rapidity and readiness of formation of traumatic aneurisms differs according to the nature of the tissue with which the wound communicates; whether the wound be in a large cavity filled with loose cellular tissue, or a space where the blood will be bound down and disposed in extensive membraniform layers by contiguous fasciæ or tense muscles. Thus in the axilla or orbit, traumatic aneurisms of large size soon follow on injury to the main artery, or even to a comparatively small branch. The well-known case of Lieut. Seton was an example of this fact. A wound of a branch of the external iliac, the patient being stout and the cellular interval large and loose, occasioned an extravasation of blood, which was large enough to lead to the belief that the parent vessel had been injured. In the limbs, on the contrary, the formation of aneurism as a consequence of wound of a large vessel is more rare; and when formed, they will often undergo a process of spontaneous cure by rest and simple measures. The reason for this doubtless is, that before aneurism has formed, the blood itself, bound down by tense fasciæ and strong expanded layers of muscle, exercises pressure on the wounded vessel, tending to limit the effusion and close the wound; and after the tumour has been developed, the pressure which (it must never be forgotten) the sac exerts upon its contents is materially aided by the pressure of the soft parts upon the sac.

The progress of traumatic aneurisms, therefore, is not always towards death, even if left alone; and when they are of small size they are generally easily cured. Direct pressure is peculiarly applicable; but it should be carefully regulated and adjusted, so as to avoid the danger of sloughing. Perhaps digital pressure is the most efficient and safe, if circumstances allow us to secure the services of a relay of attendants, who will make gentle and steady pressure with their hands over the sac. Or in very small aneurisms lying against a bone, the patient may be directed to keep his finger on the pulsating part whenever he can. I have seen a small temporal aneurism, the result of the blow of a stone, thus treated with sufficient success to avoid the necessity of any other treatment. In larger and deeper tumours some form of bandage, with the intervention of an air-pad, may be necessary. Forced flexion of the limb is of course often advisable. With direct pressure may be combined the compression of the trunk leading to the swelling,* and the limb should be raised.

If these means fail, the artery must be tied. Some authors prefer in these cases the method of Anel to that of Hunter, arguing justly, that as the artery will be found healthy close to the tumour, one of the advantages which Hunter's method has over Anel's operation, which it will be remembered was first performed for a traumatic aneurism at the bend of the elbow, is lost. This is quite true; but the general advantage of Anel's method over Hunter's, cæteris paribus, is very slight, since the mere fact of there being a portion of artery pervious between the ligature and the tumour hardly ever affects the progress of the case. If, therefore, the tumour be deeply seated, and it would be difficult to expose the vessel, as it leads into it, no hesitation need be entertained in trusting to the Hunterian method, while if (as is usually the case at the bend of the elbow) the tumour and the artery on which it is seated be superficial, the old operation of opening the sac and tying both ends of the vessel offers no special difficulties, and is certain to succeed. It is therefore often adopted; and we shall see, when treating of axillary aneurism, that it has been recommended by a high authority for general use in that form of the disease. Still, the great majority of traumatic aneurisms have yielded to the proper application of pressure, and few of those which have not done so are known to have resisted the Hunterian operation. It is only in cases in which the tumour is superficially seated, and the operation therefore comparatively easy and bloodless, that the majority of Surgeons would prefer the old operation.

Traumatic aneurisms from contusion or sprain, without external wound, are too closely allied to those of spontaneous origin to call for any special notice in this place. This form of injury is nearly related to the obstruction of the arteries, which is noticed in the essay on WOUNDS OF ARTERIES, vol. i. p. 672. The difference seems to consist in the complete or partial division of the coats of the vessel; the former leading to aneurism external to the artery, the latter to the formation of a coagulum and the obliteration of its tube. It is possible, however, that some aneurisms (and amongst others many of those called spontaneous) may arise from the laceration or paralysis from injury of the middle coat of an artery, and the protrusion of the blood through the space thus left into the cellular coat, which it distends.* The point is one of anatomical rather than of practical interest.

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* See a case of traumatic aneurism of the radial artery, cured by a combination of forced flexion of the elbow and compression of the brachial, and afterwards by extension of the arm. *Brit. Med. Journ.* 1860, p. 859.

Notwithstanding the remarkable immunity which arteries enjoy even in the most formidable injuries, it is not surprising that, as they lie so close to the bones in many situations, they should occasionally be wounded by splinters, or ruptured from sudden stretching in fractures. This accident is not common; and it usually happens in such severe injuries that amputation is necessary: some cases, however, are left, in which laceration of an artery occurs as one of the complications of a simple fracture, or of a compound fracture in which the other injuries are not very grave. In the latter case, no great difficulty can exist in deciding on the necessary treatment. If the limb is to be saved, the wound must be enlarged, and the wound of the vessel treated irrespective of the fracture. But when a large blood-vessel is wounded in a simple fracture, it is not always easy to make out in the first place whether the wounded vessel is an artery or a vein; and if the former, whether the main artery of the limb or one of its branches. In deciding between an artery and a vein, the chief guide, of course, would be the presence or absence of pulsation in the collection of blood; but then pulsation is often not perceived at first,—not till the blood has become encysted, and the case therefore has changed from a wound of the vessel to a traumatic aneurism. Another important symptom is the state of the pulse below the injury; but this may be obscured by the ecchymosis and other swelling. Again, bruit may be heard at the seat of the injury; and this, although it does not quite settle the point,† yet is perhaps the most accessible and trustworthy of all the symptoms.

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* See Rokitansky, op. cit. vol. iv. p. 299.

† A case occurred lately, at King's College Hospital, in which, after injury, with protrusion of one eye, a bruit was distinctly heard over that side of the head. No hesitation was experienced in coming to the conclusion that the case was one of aneurism in the orbit, and the carotid was tied. The patient died; and after death no trace of aneurism could be

Now, in such a case as this three courses are open: viz. to cut down on the seat of fracture and search for the bleeding vessel; to amputate the limb; or to leave the case to the powers of nature, aided of course by rest and suitable position.

In John Bell's *Surgery* this species of traumatic aneurism is very fully discussed; and he seems to have been of the opinion that it was always necessary, in cases not severe enough to demand amputation, to cut down and tie both ends of the vessel.* That this severe operation is, at any rate, not always necessary, is clear from the fact that four cases have occurred at the Middlesex Hospital, under the care of Mr. Moore and Mr. Mitchell Henry, in which such traumatic aneurisms have formed and have got well spontaneously. Short notes of one of these cases, which was under Mr. Moore's care, may be appended, as illustrating the subject better than a lengthened disquisition.

A woman, æt. forty-two, presented herself in the middle of the day, having on the previous night fallen down stairs and injured her right arm. The whole of the hand and fore-arm and part of the upper-arm were tensely swollen, and covered with bullæ of various but principally small size. Serum mixed with blood filled the bullæ. It was easy to make out a fracture of the olecranon; but it was impossible to perceive any fracture of the humerus, and the bones of the fore-arm appeared to be in place. She refused to come into the hospital, but was admitted next day. The swelling was then larger, and the vesications more extensive. There was an

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perceived. The cause of the sound remained obscure. The case will be hereafter referred to under the head of Orbital Aneurism.

* "When an artery is thus lacerated, along with fracture of the bones, you have but this alternative, to cut the limb off at once if it be very desperately wounded, or to try to save it, by making incisions and tying the artery. The fracture is already complicated with aneurism, and you are under the dangerous necessity of converting this complicated aneurism into a compound fracture. You apply your tourniquet, make a long and deep incision, turn out the coagula of blood with your fingers, cleanse the sac with sponges, search for the artery, and tie it up above and below where it is torn. You wash out the blood from the sac with syringes and sponges, for while it lies betwixt the bones they cannot unite; what blood you are forced to leave melts down into bad matter and flows off; the deeper parts of the wound gradually digest, granulate, and fill up with soft flesh; and when the continuity of the parts is thus restored, the new bone or callus begins to form. Such is the activity of a wounded artery in forming its aneurism and destroying the surrounding parts, and so complicated is the disorder when a wounded artery is added to a fractured bone, that unless these operations are performed early, the limb is inevitably lost." John Bell's *Surgery*, Charles Bell's edit. 1826, vol. iv. p. 404.

aneurismal pulsation in front of the elbow, strong and expanding, but deeply seated. The impulse extended halfway up the inner side of the arm, and more than halfway down the whole palmar surface of the fore-arm. A distinct bruit was heard with the stethoscope in front of the elbow. The two arteries at the wrist beat so forward and so forcibly, and appeared so much larger than those of the other side, as to give the idea that they had been raised by extravasated blood, and that the pulsation was communicated to the distended sheaths of the vessels. The skin of the hand was dusky from congestion; and when the colour was driven away by pressure, it returned very slowly, showing the embarrassed condition of the circulation. The limb was every where warm, however, and there was no sign of impending gangrene. A consultation was held, at which various opinions were expressed as to the appropriate treatment; but it was agreed that there could be no doubt that some large artery, possibly the brachial, was wounded. It was ultimately decided to watch the case. In the evening the swelling was found not to have increased, and the hand was certainly less tense. A rounded swelling was found near the armpit, in the neighbourhood of the brachial artery, which appeared to be the end of the clot of blood. On the following day (the third from the accident) pulsation had ceased in all other parts, and was perceptible only in front of the elbow, over a space about as large as a half-crown, and not strong. Next day the aneurismal pulsation finally disappeared, and the swelling afterwards gradually subsided. When the subsidence was sufficient, fracture of the lower end of the humerus was detected. The case did well.

Of the other three cases, one, under Mr. Henry's care, was a wound of the posterior tibial artery, in a boy who suffered from simple fracture of the leg. The diagnosis rested upon the absence of pulse in the artery, and the presence of bruit, together with peculiar restlessness of the limb. The fracture healed slowly (in about two months), and the above symptoms gradually subsided; but the pulse did not return in the affected artery. In the third case (Mr. Moore's patient), one of simple fracture of the femur in a man æt. thirty-five, there was extensive swelling, together with arterial bruit in some artery,—not the femoral, which could be felt below the seat of injury. Here also the bruit and swelling disappeared with rest, and the fracture united in three months. The fourth case, also under Mr. Moore's care, was, like the second, a wound of one of the tibial arteries in fracture of the leg. It will be noticed that the majority of these cases were merely wounds of the artery, and not aneurisms in the strict sense of that term; since they recovered without the formation of any aneurismal sac.* This fact seems to testify, even more strongly than the mere occurrence of spontaneous cure, to the decided tendency to recovery manifested by wounds of healthy arteries when uncomplicated by external injury.† The formation of an aneurismal sac, far from being an unfavourable feature in the progress of the case, is part of the process of cure. It seems abundantly clear, therefore, that surgical interference in these cases can only be justified by the presence of alarming symptoms; and that, by the aid of simple position, and perhaps in appropriate cases light and even compression, a great number of arteries wounded in fracture will heal.

The clot sometimes softens, and suppuration occurs; and this again may lead to the spontaneous cure of the injury. An interesting instance of this spontaneous ejection of the clot may be found in Ormerod's *Clinical Collections*, p. 143, after rupture of the femoral artery in a child, the patient recovering, with only the loss of two toes by gangrene; but the limb was useless.

There are, however, no doubt, cases in which things do not proceed so favourably; and this unfavourable course tends in one of two directions,—either that no aneurism forms, but the extravasation of blood increases, and thus the circulation is so far disturbed that gangrene is either commencing or appears imminent; or that an aneurism has formed, and its increase calls for some operation to check it. If no aneurismal sac has been formed, and the extravasation of blood is increasing, gangrene will soon commence. The only way to prevent it would be to cut down, as recommended by John Bell, upon the wounded vessel; but the opportunity will rarely occur. When gangrene has absolutely set in, it appears theoretically possible that a similar practice might be occasionally advisable; but in all the cases of which I have knowledge, amputation or death has been the alternative. Still, the relief to the circulation afforded by the removal of the extravasated blood might, in some rare cases of injury to the upper extremity, determine the Surgeon to cut down upon the seat of injury, as a last effort to save a portion at any rate of a hand in which gangrene had absolutely commenced. This is a matter which would depend entirely upon individual judgment, based upon the symptoms of the case in hand. In the second case, that in which an aneurism has formed and is advancing, the treatment differs in no respect from that of aneurism in other circumstances and from other causes. The two cases related by Dupuytren* are well known: one occurred in his own practice; one under the care of Delpech. In both, some artery at the back of the leg (the popliteal, or one of its branches near the division) had been torn in a comminuted fracture of the bones of the leg; a pulsating swelling formed in the ham; and the Surgeon, unwilling to amputate the thigh, fearing to lay open so large a cavity and inflict such extensive injury upon the seat of fracture, and being unaware of the reparative power of nature in such cases, cut down on the femoral artery and tied it. Both patients recovered, without a bad symptom. The cases are interesting, and will repay perusal. They bear a striking resemblance to Mr. Moore's case, quoted above (p. 443); and it seems very probable that, if they had been similarly treated, they might have undergone a spontaneous cure, in the same manner as that and the other cases there referred to did. In neither of the cases related in the *Leçons Orales* was there an aneurism, properly speaking, since sufficient time had not elapsed for the formation of a sac; but the clearness of the pulsation renders it probable that the ecchymosis was tending to become limited, and that a sac would soon form; and this appears to furnish an additional reason for waiting and watching the result. When aneurism has formed, it is a sign that the cellular tissue is contracting upon the blood. This is very likely to lead to deposit of laminated coagulum in the sac. At any rate, it is highly improbable that the aneurism will begin to increase rapidly, since the patient is of course at rest and the limb in an appropriate position. Should it, however, increase, compression of the artery above will be the method most probably indicated, perhaps with gentle compression on the sac, if the fracture is sufficiently consolidated. If the fracture be firmly united, it may even be advisable to resort to forcible flexion. In cases, however, where a main artery is wounded, as well as in those where it is tied, the fracture unites very slowly. This may be noticed in the cases from Middlesex Hospital, quoted above, and has been observed by Dupuytren and others; so that the treatment of traumatic aneurism from fracture, if it increase while the patient is lying in bed, will be by compression or ligature of the main trunk; and in cases so far resembling Mr. Spence's, quoted on p. 427, that the aneurism has apparently consolidated during the repose necessitated by the fracture, but recurs on the patient resuming his active avocations, the treatment there pursued (that of forcible flexion) will very probably be as successful as it was in that case, should the situation of the tumour render it applicable.

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* To these cases of lesion of arteries in fracture may be added a case mentioned by Mr. Skey, in a discussion at the Medical and Chirurgical Society, on a paper by Mr. Syme (see infr. Axillary Aneurism). The patient, a woman, was supposed to have met with a dislocation of the shoulder, which was thought to have been reduced. A very large aneurism formed in the axilla. The tumour was laid open. Great hæmorrhage followed; but this was soon checked, and both ends of the vessel were tied. The woman died. It was found that the artery had been wounded by the sharp ends of a fracture of the neck of the humerus.

† I would remind the reader of the many instances in which arteries have been wounded in subcutaneous section of tendons, and the rarity of consequent mischief.

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* "Sur les Anévrismes qui compliquent les Fractures," &c., *Leçons Orales*, tom. ii. pp. 521, &c., Paris, 1839.

Aneurisms the result of fracture are not confined only to the arteries of the limbs, but may form in any part where an artery lies sufficiently near to a bone to be involved in the injury. Thus Mr. Busk and Mr. Curling have each put upon record a case in which a traumatic aneurism formed upon the ophthalmic artery as a consequence of fracture of the base of the skull.* In both cases the carotid artery was tied, and with complete success. See below on Orbital Aneurism.

T. HOLMES.

Arterio-Venous Aneurism.

Under this title are included the forms of aneurismal dilatation of an artery communicating with a vein. The merit of accurately describing this kind of aneurism is due to William Hunter; and of their subsequent study and denomination, mainly to Cleghorn. Since his time we have recognised two forms of the disease, known respectively as varicose aneurism and aneurismal varix.

Varicose aneurism consists of a circumscribed consecutive aneurism, which communicates with the artery on one side and the vein on the other; the vein is always tortuous and dilated, sometimes to an enormous extent. Aneurismal varix presents a simpler condition. Adhesion has occurred between the artery and vein at the point of communication; there is no intervening aneurismal sac, and the blood is projected directly from the artery into the vein at each pulsation. Here also the veins connected with the diseased part are greatly dilated, and it is owing to the embarrassment of the circulation thus produced that the injury commonly becomes the cause of distress to the patient, and claims the care of the Surgeon.

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* *Med.-Chir. Trans.* vols. xxii. xxxvii.; see also the first of Mr. Nunneley's cases, in vol. xlii.

Both of these forms of arterio-venous aneurism may originate traumatically, as the effect of violence, or spontaneously, as the result of disease. A traumatic arterio-venous aneurism may follow a wound at any part of the body where a large vein is in so close a juxtaposition with a large artery that they may be simultaneously pierced. By far the most frequent cause is the unskilful performance of venesection at the elbow; but any other punctured wound, the impact of small shot, injury from the fragment of a comminuted fracture, and it is said even simple contusion, have led to this condition.

In spontaneous arterio-venous aneurism, the communication with the vein apparently follows upon the development of a simple arterial aneurism in the contiguity of a vein. When an aneurism is formed on a large artery, in such a part of the artery as to compress a neighbouring vein, it is common to find that vein obliterated; and in the museum of every hospital there may be seen preparations showing the obliteration thus effected of the largest veins, the venæ cavæ being frequently so occluded. But occasionally, in lieu of effecting the closure of the venous channel, the pressure of the aneurismal pouch of the artery gives rise to absorptive ulceration of the coats of the vein, and the sac opens either by rupture or by ulceration into that vein. This happens especially within the thoracic and abdominal cavities, when aortic aneurisms press upon the great venous trunks of the chest and abdomen.[*]

Less frequently, arterio-venous aneurisms arise in the same way on the limbs, and on other parts of the trunk. Sometimes they occur long after the infliction of a wound which had affected the artery, but which had been perhaps almost forgotten. Thus Rokitansky observed an axillary aneurism of this kind thirty years after a shot had taken effect on the spot. Roux[†] relates a case in which arterio-venous aneurism at the elbow formed four years after venesection; and Monneret[‡] has described an aneurismal communication between the femoral artery and the vein, said to have arisen twelve years after injury from a shot.

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[*] The earliest and most complete monograph on these forms of aneurism is due to Thurnam, *Med.-Chir. Trans.* vol. xxiii. See also Rokitansky, *über einige der wichtigsten Krankheiten der Arterien*, Wien, 1852, p. 46 et seq.; Porter on Arterial Disease, in Todd's *Cyclopædia of Anatomy;* Nélaton's *Clinical Lectures*, by Atlee; Mayn, *Dublin Med. Journal*, 1854.

[†] *Bulletin de l'Acad. de Méd.*, Paris, 1849.

[‡] *Bulletin de Méd. et Chir.*, 1852.

Again, spontaneous arterio-venous aneurism has been described by Bransby Cooper,* by Perry,† and Porter,‡ affecting the femoral vessels in cases where the disease could not be traced to any other cause than primitive disease and thinning of the coats of the vessels. In the highly interesting case related by Mr. Perry there was more than one communication.

It is usually a main artery and its collateral vein which are thus affected; and it may be readily understood that, from their close contiguity and often superficial position, these would be more likely to become the subjects of this diseased connexion; but the elaborate investigation of Follin and Charnal,§ and the cases of Puydebat‖ and Pancoast¶ have shown that deeply-seated veins, as well as superficial veins, may be thus affected. In the case of M. Follin, a communication between the brachial artery and a deep vein was diagnosed during life, and subsequently proved by the dissection of M. Charnal. Schottin** has seen a similar connexion between the radial artery and the cephalic vein.

The symptoms of these two forms of arterio-venous aneurism have some peculiarities in common, due to the communication between artery and vein. The most characteristic is a vibratory thrill, which results from the impulsion of the arterial blood into the patent aperture of the vein, there to mingle with the venous current. The greater tension of the arterial than the venous wall, and the greater force of the arterial flow of blood, causes a continuous injection of arterial blood into the venous tumour; but the pulsation of the artery produces a synchronous impulse in the flow of the blood through the tumour. Hence the peculiar vibratory character of the thrill, which is otherwise continuous. The ear detects a harsh, buzzing sound, which has been variously compared to that of a saw, a file, a bee, the hissing of burning metal plunged into cold water, and similar noises. This sound too is continuous, although momentarily increased during diastole. It grows fainter on being propagated along the artery, and at some distance from the aneurism in which it arises it seems intermittent, the louder diastolic sound only being then heard. This sound may be so loud as to be audible by a person standing near the patient; but that is exceptional. It may, however, always be distinctly heard with the stethoscope, or by the naked ear; and its continuous character sharply distinguishes an arterio-venous from a pure arterial aneurism. Considerable dilatation of the veins, a third symptom, is consequent upon the obstruction of the venous circulation by the entrance of arterial blood flowing in an opposite direction, and upon the general increase thus made to the quantity of blood which the vein must carry towards the heart. The extent of this dilatation varies according to the size and importance of the vessels affected. It is most marked in the lower limbs, where gravity aids in increasing the obstruction and consequent tendency to varicosity. Here the veins have been described like knotted ropes beneath the skin by Porter, Perry, Langier, and others. In a case where the temporal vessels were affected, and which Mr. Moore very carefully described to the Medical and Chirurgical Society of London, in a brief but valuable communication, the veins were enormously dilated, and pulsated so strongly as entirely to simulate arteries during the operation performed.

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* *Guy's Hospital Reports*, vol. v.

† *Med.-Chir. Trans.* vol. xx.

‡ *Todd's Cyclop.*, "Arteries," p. 242.

§ *Bulletin de la Soc. de Chir.* vols. iii. v.

‖ *Bulletin de la Soc. Anat.*, 1834.

¶ *Fergusson's Handbook of Surgery*, 1852.

** Schottin, *Merkwürdiger Fall einer aneurismatischen Venengeschwulst.* Altenburg, 1825.

This pulsation of the veins is a fourth important symptom which deserves to be borne in mind; because the Surgeon may be, and has been, induced by it to place a ligature round one of the veins, thinking it to be an artery. William Hunter noticed that the arteries below the point of communication beat more feebly than in the healthy body; and naturally, since a part of their ordinary supply of blood is directed into the vein. But this symptom is not always observed. In old-standing cases a remarkable condition of dilatation is observed in the arteries above the varix. They become enlarged, tortuous, and thinned in structure. Indeed the veins around the arterio-venous aneurism assume more or less of the arterial character, and the arteries approach somewhat the type of veins. This has been observed by all who have described these cases, and has been well summarised by Rokitansky in his monograph on the pathology of the arteries. I have now under my care a man advanced in years in whom a diseased communication exists between the superficial veins of the abdomen and an arterial branch; probably an anastomotic vessel communicating with the superficial epigastric and internal mammary trunks. The veins are enormously distended, forming a convoluted and tortuous mass, projecting from the lower part of the abdomen from the navel to the groin, where they communicate with the left saphena. All the above signs are present. The condition has existed for nearly a score of years, and has caused little inconvenience.

The varicose aneurism differs from the aneurismal varix as we have seen, in that it possesses an aneurismal pouch which is intermediate between the opening of artery and vein. It is, of course, important in practice to recognise this difference, and mark its peculiar symptoms. This circumscribed aneurismal tumour will be found of various size and density, according to the site and duration. It rarely attains, however, any considerable size. It is affected in the same way as pure arterial aneurisms when the artery is compressed above or below it, and the ear detects the blowing sound of an aneurism, in addition to that rasping bruit described as the result of the venous communication.

In both forms of arterio-venous aneurism, it may be said that we find a soft, fluctuating, knotted, and imperfectly circumscribed subcutaneous tumour. It can be emptied by pressure upon the tumour itself, or the artery leading to it. It has distinct pulsations; but these are limited to a very small part of the swelling at the level of the point of communication between the vessels, gradually becoming extinct in the ratio of distance from that point. In this it is distinguished from arterial varix, or cirsoid aneurism, which offers pulsation of equal intensity over the whole extent of the tumour; it may be further distinguished from that affection by the blue or purple colour of the tumour, and by the tortuous dilatation of the veins leading to it. Further, to distinguish it from arterial varix, to which it presents so many points of external resemblance, it may be added, that while in both auscultation detects a loud, rasping, continuous bruit, this sound is heard over the whole surface f the arterial varix, but only at the point of communication in the arterio-venous aneurism, or, if it radiates therefrom, it can then nly be traced along the course of the artery, and becomes gradually extinct.

The treatment of aneurismal varix and varicose aneurism must e mentioned separately; that of aneurismal varix presents great difficulties. In many cases indeed the disease manifests but little tendency to advance, and, where this stationary condition exists, surgical interference may well be omitted. In Mr. Moore's case, thirty-six years had elapsed before any operation was necessary; nd Hunter, Cleghorn, Porter, and indeed all other authorities on this subject, have seen this occur. It is especially the case in the upper extremity. In the lower limb, however, the disease may extend so greatly as to destroy the use of the limb, or to threaten the destruction of the patient's life by hæmorrhage. In the case referred to, as related by Mr. Perry, the Hunterian ligature was twice performed, but without effecting the cure of the disease. In a case mentioned by Mr. Bransby Cooper, it was considered necessary to amputate the leg. Should the Surgeon now be called upon to treat, by operative means, an artery so affected in either of the extremities, he would probably attempt to obtain the closure of the arterial aperture by indirect pressure on the artery above the communication. The use of direct pressure has rarely been of any good effect. There are, however, two proceedings which are more promising: the injection of coagulating fluids at the site of the disease, applied carefully, with the minute precautions necessary for the success of that plan; or ligature of the artery above and below its aperture of communication. Before employing either method, it would probably be desirable to resort to digital or instrumental compression, or, if the position allowed, to forcible flexion. But the constant passage of the arterial blood through the apertures resulting from the arterio-venous communication, and the absence of any defined sac, impede the formation of the fibrinous deposit to which these methods owe their success; and cases of aneurismal varix of this form are not very amenable to treatment by indirect compression. An interesting case is recorded in the *Proceedings of the Anatomical Society of Paris*, for 1858, in which indirect compression having been carefully tried, but without success, a ligature was applied by M. Robert above and below the aperture in the artery. A few cases have been recorded of aneurismal varix within the skull.* In one of these, recently, compression was applied over the carotid, but ineffectually; in this case, the internal carotid artery communicated with the cavernous sinus; and death occurred as the result of profuse hæmorrhage from the nose. In such cases, of course only the Hunterian ligature is possible; but where the artery is more accessible, it is obviously more desirable to apply a ligature above and below the diseased communication.

The treatment of varicose aneurism is somewhat different in kind; for here a sac intervenes between the artery and the vein, but it is similar in principle. Here also direct and indirect compression have been largely tried, but have not yielded satisfactory results; nevertheless, digital compression might be employed in the less aggravated form, not without hope of cure.

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* *Bulletin de la Société Anatomique*, vol. xxix. p. 298; vol. xxx. p. 178.

Should it be necessary to apply the ligature, it is requisite to eject the method of Hunter in favour of the ancient proceeding. he most simple plan is to lay open the sac, trace it into the artery, nd having exposed the aperture in the artery, for which purpose is commonly necessary to divide the sac transversely on a director, hen to apply a ligature above and below the arterial opening. This ethod is more simple than that which has been employed by Roux nd Fergusson, who have endeavoured to isolate the artery, and tie above and below without opening the sac at all. This is the more ifficult, that the artery below its point of communication is small, nd surrounded by veins dilated and closely packed. On the other and, it is free from the objection attaching to the plan first decribed, arising out of the danger of putting two ligatures close to e sac, and at a point where it is surrounded by dilated veins. In ny case the operation is peculiarly liable to one of two secondary ccidents, hæmorrhage and gangrene: hæmorrhage from the part f the artery above the sac where it is dilated, thinned, and gives ise to numerous collateral branches; and gangrene of the limb elow, which perhaps already, before the operation, was cold, enumbed, and œdematous. The injection of a weak solution of erchloride of iron has been employed by Serres and Jobert,* Veleau,† and Vallette,‡ twice with perfect success; once producing uppuration of the sac, followed by cure, and once, by M. Velpeau, effectually. These facts are in favour of this method of treatment; nd as the safeguards against the accident of suppuration are more arefully studied, the plan may recommend itself still more strongly the Surgeon.

Galvano-puncture has been employed by Bosse and Capeletti. n Bosse's case two steel needles, connected with thirty-two pairs f galvanic plates, were introduced into the aneurismal tumour, nd retained there for eighteen minutes. The cure was completed ithin ten days. In Capeletti's case the needle was introduced wice; suppuration followed, and ultimately a cure. M. Debout as also recorded a successful case.§

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* *Bulletin de l'Acad. de Méd.*, 1854.

† "Traitement de l'anévrisme artério-veineux," *Bulletin de l'Académie de édecine*, 1854.

‡ *Acad. de Méd. Paris*, May 23, 1859.

§ See Wernher, *Handb. der Chir.*, vol. iii. p. 821. Ciniselli *sulla Elettrountura nella cura degli Aneurismi*, Cremona, 1856. Debout, *Bulletin de hérapeutique*, 1847, p. 123.

Cirsoid Aneurism, and Aneurism by Anastomosis.

By cirsoid aneurism, or arterial varix, is understood a form of disease which consists in a simultaneous elongation and dilatation of an artery. The structure of its wall exhibits in the beginning no alteration, although the coats become thinned during the progress of the enlargement. It will be observed that this lesion is not strictly included in the terms of the definition which was given of aneurism, and recent authors have agreed that the disease is improperly denominated aneurism; hence it finds no place in the most modern monograph on that subject. But both by its character and accepted title it claims our consideration here.

It is especially the middle coat of the artery which is affected when the process of thinning commences. This structure becomes pale, soft, and thin, so that the arteries look like thin veins. The dilatation is commonly equal throughout the circumference of the artery; but in the more severe cases the artery is greatly dilated, and presents unequal saccular pouches, which are, in fact, so many true aneurisms, projecting usually towards the surface of the skin. As the artery elongates, it becomes tortuous and serpentine; sometimes even spiral. The disease is rarely circumscribed, but attacks commonly several trunks and their branches. M. Broca, however, has recently described a case of perfectly circumscribed cirsoid aneurism of the scalp, treated successfully by the injection of perchloride of iron.* It may occur in the arteries of the extremity, and Cruveilhier has reported a remarkable case of cirsoid aneurism of the external iliac artery. But it is more especially frequent in the arteries of the scalp, and in this situation more instances have been recorded than in all the other parts of the body taken together. Originating usually in one of the arteries of the scalp, it extends itself to the branches of the other side of the head, and may widely implicate the connected vessels. On the one hand, it may pass into the capillaries, widely dilating them, and affecting even the terminal veins in its march; or on the other, but in a smaller degree, it may affect by retrogression the larger branches from which the arteries of the scalp arise, passing even into the carotids. It is thus that it changes somewhat its anatomical characters. The venous capillaries and trunks become affected by the extension of the disease, and the arterial network becoming highly and morbidly developed, this form is known by the name of *aneurism*

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* *Bulletin de la Société de Chirurgie de Paris*, 1859.

by anastomosis. The pathological condition and the principles of treatment are essentially the same; but when the disease is seated in the larger arterial trunks, it is commonly known as cirsoid aneurism; when it extends into the network of capillaries, it is known as aneurism by anastomosis, or racemose aneurism. It attacks most frequently the superficial temporal, the posterior auricular, and the occipital arteries. Commonly the surrounding tissues suffer but little injury; but sometimes the subcutaneous cellular tissue may be atrophied, and the skin dangerously thinned; at other times the soft parts may be thickened and indurated; sometimes the bones are grooved, or even perforated.

The causes which give rise to cirsoid aneurism are not apparent. Occasionally its origin has been referred to a blow, or to an injury of a congenital erectile tumour; more often no cause can be assigned, and it is not evident why the scalp should be the chosen seat of this disease. It may be noticed here that the majority of cases occur in persons whose age varies from fifteen to thirty. The diagnosis of the disease can hardly be a source of difficulty, for the serpentine and pulsating character of the tumour afford a distinguishing sign. The manner of diagnosing this affection from varicose aneurism or aneurismal varix has been mentioned in the last section. But where it is associated with dilatation of the veins, some difficulty may arise in distinguishing it from the so-called erectile tumour, or teleangeiectasis, from which it is, however, still distinguished by its pulsations. Such cases have been recorded by Pelletan,* by Dupuytren,† and others.

The treatment of this disease commonly offers great difficulties and many risks. The frequency with which direct failure has followed various procedures, the yet greater frequency of relapse, and the occasional fatal termination of operations which have been undertaken, are reasons for caution in dealing with this disease. Unless there is cause to fear that by its extension or by its severity it may prove fatal to life, it is commonly the more prudent course to abstain from operative interference. Cirsoid or anastomosing aneurism is not always a source of imminent danger, and it may exist for many years without any other evil effect than that of inconvenience; and, indeed, in some of the least unfortunate cases it has so continued after various operations. Even where extensive and severe, it cannot always be treated with advantage.

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* Pelletan, *Clinique Chirurgicale*, Paris, 1810, vol. ii. p. 59.

† Dupuytren, *Leçons Orales*, Paris, 1839, vol. v. p. 43.

The simplest method of treatment is by compression; but this is also the most ineffectual. I am not acquainted with any case in which it has proved successful, although trials have been recorded by Dupuytren, Robert,* and Brodie.† If palliation be desired, little more can be done than to provide a metal covering to protect the affected part, where the locality admits of such a provision, or by bandaging to afford local support. The ligature of the branches directly leading to the affected part has been often tried; but this also has rarely succeeded. In a case in which Breschet tied the temporal artery in a girl eighteen years of age, for a severe form of the disease, death from pyæmia took place on the fourteenth day,‡ the ligature having been carried through and not round the vessel. Maclachlan tied the temporal artery, also without success, and followed it by ligature of the common carotid.§ In a patient of Dupuytren's, both the temporal and occipital arteries had been tied unsuccessfully.‖ Gibson tied the main branches of the temporal and occipital artery for a similar case ineffectually.¶ The records of the results of this proceeding are not in its favour.

The ligature of the external carotid has been performed for a cirsoid aneurism of the scalp by Maisonneuve.** He tied the right external carotid for a cirsoid aneurism of the right temporal artery occurring in a woman thirty years of age two months after a blow. The patient was suffering acute pain, and the disease beginning rapidly to extend. Besides tying the external carotid, he put a ligature also round the superior thyroid artery. Pulsation ceased, the tumour diminished, and all went well for the first three weeks. Secondary hæmorrhage followed the separation of the ligature, and Maisonneuve tied successively the common and the internal carotid arteries. The latter operation was followed by hemiplegia, and, after three days, by death. The brain substance of the right hemisphere was found to be deliquescent. This case had, therefore, a very unfortunate termination; but it is worthy of especial note, because it is, perhaps, the only recorded instance in which the external carotid artery has been tied for cirsoid aneurism of the scalp, and because that proceeding would appear on anatomical grounds to be the best calculated to arrest the circulation in the part affected. Prof. Bruns,* who has given great attention to this subject, points out that the ligature of the external carotids is the proceeding best calculated to cut off the supply of blood to aneurisms of the scalp. He urges that the external carotids of both sides should be ligatured in such cases, and certainly where it is necessary, from repeated local hæmorrhages or threatened rupture, to employ serious surgical interference, the ligature of one, and still more of the two external carotids, would best effect the diminution in the supply of blood to the arteries in the scalp; for then only the supra-orbital and frontal branches of the internal carotid would remain capable of supplying blood in this direction; and unless the disease were seated in the forehead, their influence need hardly be feared. Posteriorly the blood would reach the scalp only through the anastomosis of the occipital arteries with the ascending cervical branches of the subclavian and the muscular twigs of the vertebral artery; whilst in front some further assistance would be given by the connexion of the inferior thyroid branch of the subclavian with the superior thyroid branch of the carotid. This might not be unworthy of the consideration of Surgeons in future cases.

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* *Gaz. des Hôpitaux*, 1851, p. 130.

† *Lancet*, 1828-9, vol. ii. p. 559.

‡ Breschet, *Mémoires Chirurgicaux sur les différentes espèces d'Anévrismes*, Paris, 1834, p. 54.

§ *Lancet*, 1827-8, vol. i. p. 773.

‖ *Leçons Orales*, loc. cit.

¶ *Institutes and Practice of Surgery*, vol. i., Philadelphia, 1835.

** *Bulletin de la Société de Médecine de Paris*, 1851, vol. i. p. 400.

Judging from anatomical data, the ligature of the common carotid artery, while it is pregnant with greater dangers, offers fewer advantages than the application of the same procedure to the external carotids. It has, however, been practised in at least fifteen cases, but its successes have been few. The only superiority which it possesses over the ligature of the external carotid is by shutting off the supply through the branches of the ophthalmic artery; but the large and numerous anastomoses of the carotid of the opposite side continue to supply blood, and even where a temporary improvement has followed the operation, speedy relapse has occurred, probably from this cause. Again, the disturbance of the cerebral circulation by ligature of the common carotid has of course its own peculiar dangers. So that out of eighteen cases in which the operation was performed, death occurred under the knife in three instances, and four others terminated fatally; in five an early relapse followed the first improvement; in the tenth case no final report has been given; and in only two is it stated that there was lasting improvement. Instances in which the common carotid has been tied for this disease are recorded by Robert,[*] Dupuytren,[†] Kühl,[‡] Bush,[§] Wardrop,[||] Maclachlan,[¶] Maisonneuve,[**] Walther,[††] Mussey,[‡‡] Warren,[§§] Hersche, Kerr, Zeiss, Arendt,[||||] Travers junior,[¶¶] Mott, Wood,[***] and Critchett.[†††] A proceeding which has proved so fatal in the hands of Surgeons so eminent must be regarded with great distrust. It is certain that in very many cases the dangers of this operation must be greater than those of the disease itself; and when those perils are surmounted, its success must still remain a contingency, which in the past has only three times been nominally realised in eighteen cases. Attempts have been made to cure cirsoid aneurisms by a method conceived after the old proceeding of Antyllus for true aneurisms. It has been proposed to lay open the tumour by a stroke of the scalpel, to stuff the arterial wound with lint, arrest hæmorrhage by firm compression, and trust to the inflammatory exudation thus excited for the obliteration of the arterial channel. It is obvious that this method could only be applied to those cases of circumscribed cirsoid tumour in which the artery forms a limited tumour by its convolutions, and to cases of limited aneurism, and by anastomosis. Gräfe first employed this proceeding for a cirsoid aneurismal tumour of the forehead in a boy aged ten.[‡‡‡] He divided it across with a strong scalpel, stuffed the wound quickly with agaric and sponge, and firmly strapped and bandaged the whole. On the following day, as the pressure was slightly relaxed, the wound granulated, and when the parts healed there was no pulsation in any part of the solidified tumour. Bell,[§§§] Arnott, and Lawrence[||||||] have succeeded also in curing aneurism by anastomosis, by incising the soft parts, and promoting suppuration in the tumour, maintaining compression meantime. It would not be reasonable to expect that the obliteration of a single large artery in a state of cirsoid dilatation could commonly be satisfactorily effected in this way; not only the fear of secondary hæmorrhage presents itself, but we know that arteries are but little prone to adhesive inflammation, and that arterial blood is quick to find for itself outlets and to make for itself channels. In a case of truly cirsoid aneurism this proceeding will be liable to numerous sources of failure.

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* See Bruns' *Handb. d. pract. Chir.* i., Tubingen, 1854, p. 161.

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[*] *Gaz. des Hôpitaux*, 1851, pp. 130, 128, and *Bulletin de l'Acad. de Méd.* vol. xvi.

[†] In this case of Dupuytren's the right common carotid was tied in 1809. The tumour remained stationary till 1848, when it again became very much ulcerated, and gave rise to frightful hæmorrhage. He came under the care of M. Robert at the Hospital Beaujon in 1857, when the left carotid was also tied, with temporary success.

[‡] Kühl, *Opusc. Academica*, editio Claras; Lipsiæ, 1842, p. 51.

[§] *New York Journal*, &c. 1819, vol. i.

[||] *Lancet*, 1827-8, vol. i. p. 24.

[¶] *Glasgow Medical Journal*, 1827.

[**] Supra cit.

[††] *Gräfe und Walther's Journal*, vol. v.

[‡‡] *Amer. Journal of Med. Sciences*, 1830.

[§§] *Practical Remarks on Tumours.*

[||||] Quoted by Wernher, *Handb. der Chir.*, Giessen, 1855, vol. iii. p. 806.

[¶¶] *Lancet*, vol. ii. 1857, pp. 497, 627; vol. i. 1858.

[***] *New York Journal of Medicine*, July 1857.

[†††] Critchett, *Med. Times and Gaz.* vols. xxx. xxxi.: Statistical Reports.

[‡‡‡] *Gräfe und Walther's Journal*, vol. xviii. p. 20.

[§§§] Bell, *Principles of Surgery.*

[||||||] Lawrence, *Med.-Chir. Tr.* vol. ix.

A more efficient means of destroying circumscribed cirsoid aneurism is to be found in extirpation en masse by the knife or by ligature. The latter method was employed by Sir B. Brodie with only temporary success in treating a cirsoid and anastomosing arterial tumour of the head, of the size of a walnut, which had the characteristic feeling as of a convolution of meandering vessels with strong pulsations. The tumour was transfixed crosswise, and strangulated by four threads in as many parts. The cure was reported at the time to be complete.* But Mr. Prescott Hewett mentioned in a lecture at the Royal College of Surgeons the fact that the disease recurred in this case, and that the patient died some years afterwards, death being attributed to "nervous debility."

Excision of the tumour by the knife has been several times accomplished, and has yielded cures in cases of great severity. One of the most remarkable cases on record occurred in a young man aged twenty treated by Mussey, who had on the top of his head a cirsoid aneurism† of great size. All the arteries of one side of the head were enormously dilated, and when the hair was shaved twenty arteries of the size of a goose-quill pulsated on their way to the tumour. Ligature of the left common carotid failed to cure, and the ligature of the right common carotid twelve days later also effected only a temporary improvement. Extirpation was resolved upon; two semilunar incisions being made around the tumour, which was then peeled off from the pericranium. These incisions were made gradually; the arteries wounded being tied at each half-inch, they occupied more than an hour, and forty ligatures were required. In spite of all precautions, there was a great quantity of blood lost, and the patient fell into syncope; the wound, however, granulated locally, and the patient is stated to have recovered completely. Gräfe,* Gibson,† Weitzer,‡ Busch, and Warren, have also employed this method. I employed it eighteen months since successfully, freezing the tumour and cutting wide of it; so that there was very little loss of blood. Its difficulties have proved very great, and its danger is considerable. The hæmorrhage in some of these cases was excessive. But the issue of all the recorded cases in which it has been undertaken has been successful, and excision by the knife has as yet proved a most rapid, safe, and successful means of treatment. It is obvious that sometimes great caution is required to carry it into effect, and in very extensive developments of the disease it will be inapplicable. It might occasionally be prudent to preface the extirpation of the tumour by the ligature of the main trunks which feed it; when practising the incisions around the tumour, the knife travels slowly, and the arteries are to be tied as they are divided. It was by the combination of well-timed caution and necessary boldness that some of these formidable operations have been brought to a successful issue.

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* *Med.-Chir. Trans.* 1829, vol. xv.

† Loc. cit.

Two of the more modern resources of surgical science have recently been brought to bear upon the treatment of cirsoid aneurism and aneurism by anastomosis: these are galvano-puncture, the galvanic cautery, and the injection of coagulating fluids. The case of galvano-puncture is due to Nélaton; his patient was a woman aged twenty, having a frontal tumour made up of vessels so convoluted that their windings could be clearly distinguished by the touch; it had arisen two or three months previously, after a severe blow. Two needles connected with a Bunsen's pile of 20-lb. plates were passed into the tumour where the pulsations were most violent, and the current transmitted to them during ten minutes. Next day, where the needle connected with the positive pole had entered, consolidation was found to have occurred, and after some further sittings the whole tumour had become a hard mass, and after a while was absorbed.§

A case of aneurism by anastomosis of the ear and scalp, under Mr. Prescott Hewett's care, treated by the electric cautery, is the same as that previously mentioned as having been subsequently subjected to the ligature of the common carotid with a fatal result by Mr. Travers, jun. It was treated by a combination of the electric cautery, styptics, and the ligature of the tumour en masse.

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* *Gräfe und Walther's Journal*, vol. xiv. p. 639.

† Op. cit.

‡ *Deutsche Klinik*, 1850.

§ *Bulletin de Thérapeutique*, tom. xlii. p. 354.

The result was for a time very satisfactory; the tumour having sloughed off, the ulceration healed, and the greater part of the hypertrophied vessels resumed their natural appearance. This cure was, however, not permanent. A further development of the tumour occurred, and before long it was again as bad as ever. It seems highly probable that had this patient remained under observation, the repetition of the original measures might have prevented or checked this recurrence, and so ultimately have saved his life.

The application of coagulating injections was made by M. Broca, who treated a circumscribed aneurism of the scalp, consisting of the convolutions of a cirsoid artery, by injecting perchloride of iron. Many precautions were adopted for preventing extravasation of the coagulating fluid, and the case is described as having been perfectly successful.*

ERNEST HART.

DISSECTING ANEURISM.

The affection which bears the name of Dissecting Aneurism is so seldom recognised during life, and when it is the subject of treatment falls so much more commonly under the care of the Physician, that a very few words must suffice for its description here. The anatomical lesion consists in a rupture of the internal coats of the artery, by which the blood is allowed to pass in an unnatural channel between the coats of the vessel, parallel to its course, until finally it passes again through the coats, so as to reënter the cavity of the artery if its course has been forwards, or falls back into the pericardium if it has made its way backwards. Dr. Peacock† has shown that a layer of the middle coat usually is left external to the blood, which is therefore extravasated into the thickness of this coat; and has also shown that the existence of this more resisting membrane confining the blood renders rupture into the pericardium or the cellular tissue less probable. When the coverings of the blood are strong, and the fluid finds a ready passage back into the artery, life may be prolonged for a considerable period. In fact, the symptoms referred to the disease have been observed to last for years. It is not impossible that in some such cases a dissecting aneurism may pass into a common false aneurism.‡

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* *Bulletin de la Société de Chir. de Paris*, 1860.

† *Contributions to the Pathology of the Heart and Arteries*, "on dissecting aneurism," Edinb. 1849.

‡ Thus a case is cited by Dr. Peacock (op. cit. p. 7), where the patient

The position of the original rent seems always to be in the aorta, and generally in the arch, quite close to its origin, though it has been known to be situated in the abdominal aorta, even as low as its bifurcation. The position of the secondary rupture of the inner coats, by which the blood passes back into the cavity of the vessel, varies much. A case is mentioned in which the separation extended into the popliteal artery; and in another case, in which the primary rent was in the transverse arch, the secondary opening was in the subclavian.

Death occurs soon in all cases where the blood passes out of the artery, either into the pericardium or into the surrounding tissues; and in most of those in which the blood makes its way back into the artery. But in the few instances of the latter class in which life has been protracted for years, the unnatural channel running along by the side of the natural artery is lined by a smooth membrane resembling epithelium, and thus simulates a double vessel.

The symptoms of dissecting aneurism are best illustrated by a very interesting case reported by Dr. Swayne and Mr. Keyworth, of York,* in which the diagnosis was accurately made during life, and confirmed by dissection. In that case, a man aged 51, who had suffered for some time under symptoms referred to diseased heart, with aortic regurgitation (to which diagnosis one of his medical attendants, Dr. Latham, had added disease of the aorta), was seized suddenly one evening, as he was returning from a day of some exertion and excitement, with a very severe tearing pain in the chest, instantly followed by a second agonising pain, which seemed to dart from mid-sternum down the left of the spinal column, and only to be arrested a few fingers'-breadth below and to the left of the umbilicus, at which point of arrest the patient thought he heard a distinct crack. He lost power in both lower extremities almost immediately, and the pulse became imperceptible in all the arteries of the lower limbs. A bellows murmur was heard below and to the left of the umbilicus. The 'tearing' pain recurred, and he then passed into a state of syncope, followed by great exhaustion and distress. Reaction set in next day, with much congestion, greatly relieved by bleeding. He survived about three months, dying of dropsy and hydrothorax. The pulse had recurred feebly

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survived some years; "the sac commenced at the origin of the aorta, and terminated in a cul-de-sac at the common iliac arteries." So that nothing except its shape and extent would distinguish it from false aneurism.

* *Path. Soc. Trans.* vol. vii. p. 106.

in the right femoral artery before death. The diagnosis of dissecting aneurism, originating near the root of the aorta and passing down so far as to compress the true channel of the vessel near its bifurcation, was made at the time of the seizure and confirmed by dissection. A transverse rent was found in the arch of the aorta, just below its three large branches; a clot of blood was impacted near the bifurcation of the artery, obstructing the left common iliac completely and the right partially. The old canal of the aorta seems to have been disused, and the arteries to have communicated with the new channel.*

This case will serve to illustrate the usual run of the cases of dissecting aneurisms, though it is rare for the symptoms to be so well marked or so well observed; and therefore the disease is seldom recognised or even guessed at during life. The patient is usually advanced in life, very probably a female, and suffering from hypertrophy or other disease of the heart. The first symptom is a lancinating pain at the seat of rupture, and therefore usually in the chest, followed by syncope; perhaps by pain at the part where the blood reënters the artery, or where the tumour ceases. And this may be accompanied by the cessation of pulse from impaction of clot in the old channel of the artery, aided by the pressure of the blood in the unnatural channel. This stoppage of the pulse of course causes more or less complete loss of power. In other cases, where the rupture occurs near the heart and the blood falls back into the pericardium, death is sudden. I can add nothing as to the diagnosis of the disease which may not be gathered from the symptoms in the above case. The only case in which I can conceive such an affection becoming the subject of surgical diagnosis, is where loss of power, loss of pulse, and threatening gangrene follow on dissecting aneurism; and the diagnosis lies between this disease and embolism from the more ordinary causes of impacted clot.

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* In this case, Dr. Swayne, after having his attention specially drawn to the fact by Dr. Peacock, distinctly asserts that the extravasation was *between* the external and middle coats.

GENERAL OBSERVATIONS ON THE LIGATURE OF ARTERIES.

It is in operations for the ligature of arteries that the proceedings of the operating theatre most nearly resemble those of the dissecting room; and it is in these operations, more than in any others, that minute anatomical knowledge is advantageous. Before undertaking to tie an artery, the Surgeon ought to know its general course and its relations, and especially the prominent part or parts which are to guide him to the position of the vessel (to serve as rallying points, as the French operators say); he ought to have familiarised himself by frequent dissection* with the thickness of the parts covering it, and their appearance, as far as that can be judged of on the dead body; and, finally, he ought to know the usual position of its principal branches, and the anastomoses by which the circulation may be expected to be restored. It is advisable also to be aware of the leading peculiarities in course, relations, bifurcation, &c., which the operator may perhaps meet with, and for which he ought to be prepared.

Having all these anatomical details clearly present to his mind, and being familiar with the various methods by which the vessel can be reached, the Surgeon will be prepared to adopt that method which seems to him best suited to the case which he happens to have before him. It is better, if possible, to avoid the part of an artery where large branches are known to come off, since in such cases the clot that should form in the vessel during the process of its division will be absent between the ligature and the opening of that branch; and although it is true, as has been shown above,† that the clot is not necessary as a preservative against secondary hæmorrhage, inasmuch as the wound in the artery unites by lymph, which seals it, and acts as a barrier to the blood; yet that barrier is certainly strengthened by the clot in the artery, as is shown by the fact that secondary hæmorrhage is less common in situations where a long internal coagulum is formed.

In dissecting down upon an artery, it is important to have a clear view of each successive structure as it is exposed; and therefore bleeding from any small veins or arteries that may be divided in the superficial incision should be at once restrained by ligature or pressure. No attempt should be made to hurry over the proceedings; but as each layer of tissue is divided, the one below should be carefully examined with the eye and finger. Most large arteries run in a sheath of fascia, which also contains their accompanying vein. When the level of this sheath is reached, great care must be taken in applying the knife. The cellular membrane or muscles over the sheath having been properly divided or drawn aside, that structure itself should be cleaned by scratching with the finger, assisted by the blunt point of a director or silver knife. When the sheath has been fairly exposed, and the beating of the artery can be plainly felt through it, a small part of the membrane should be raised by the forceps and divided with the knife held horizontally, as is done in opening the sac of a strangulated hernia. The small hole over the artery must be extended with the point of the director or aneurism needle,* till a little channel has been made round the vessel, through which the thread can be carried easily. Great care is necessary to use the instruments with all gentleness at this stage of the proceeding, on account of the proximity of the vein. The needle is to be passed under the artery, in a direction away from the vein; *i. e.* the point of the needle is first passed between the artery and vein, and brought out on the side of the artery away from the vein.† When the needle has been passed under the artery, the latter should be compressed between the point of the finger and the curve of the needle, in order to see that the beating in the tumour is completely stopped, or the bleeding completely commanded; and to judge also by the feeling that no other structure has been taken up with the vessel. This is the more necessary in cases where the artery, as in the case of the subclavian, lies very deeply, perhaps out of sight, and touching a large nerve or other important structure.

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* So experienced an operator as Sir P. Crampton relates, that before tying the common iliac artery he practised the operation seven times on the dead subject, and says that each time he did so he learned something towards the satisfactory performance of the operation.

† See Guthrie's *Comment.*, ed. 1855, p. 80; Porter *on Aneurism*, p. 187; Aston Key, in *Guy's Hospital Reports*, vol. i. pp. 65, 66.

Some difference of opinion exists about the administration of chloroform in operations on arteries. M. Robert‡ advocates the performance of these operations without anæsthetics, but the contrary practice is now universal, and I think rightly so, in this country. Opinions differ also as to the direction in which the incisions may be most advantageously made. Most operators make their incisions in the course which the vessels are known to pursue; others prefer an incision which crosses obliquely the course of the vessel. The former plan enables the operator more clearly to anticipate and recognise the structures successively exposed; the latter renders him more certain not to miss the vessel altogether, and also enables him more conveniently to investigate the parts around, should any anomaly, such as a high bifurcation of the brachial or femoral artery, render it necessary to search about, without any definite anatomical guide, for a vessel not usually present.

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* Mr. Syme, however, whose experience in tying arteries is perhaps more extensive and more favourable than that of any other living operator, prefers cleaning the artery with the edge of the knife, using it till the whitish coat of the artery is clearly seen. If this plan is adopted, great care must be taken in scratching the vessel; and perhaps it will be well to blunt the edge of the knife a little.

† Further directions as to tying arteries for a wound will be found in vol. i. pp. 689 et sqq.

‡ *Conf. de Clinique Chir.*, Paris, 1860, p. 48.

Large arteries ought not to be tied unless a reasonable probability exists of the recovery of the patient from an operation which must always be grave, and which is far more fatal than most Surgeons appear inclined to admit; but if the disease or injury admits of no other cure, nothing need be held to be a formal contra-indication to the operation; not disease of the viscera, not disease of the heart, not even disease of the artery itself, although it must be allowed that the latter complication renders the case almost hopeless.* But on the other hand, the most mature consideration is requisite to assure the Surgeon that the case is really beyond the reach of other and milder measures. So much has lately been done to diminish the percentage of cases of aneurism which require ligature, that it may now be said that the presumption in a case of surgical aneurism is rather that it is curable without operation than that an artery will require ligature. It will be my object in the following remarks upon each particular form of surgical aneurism, to point out in what cases milder measures may be expected to succeed; and when these fail, by what operations the affected arteries or the trunk above them can be reached; and in treating of each form, I shall observe the same order as is followed in the essay on AMPUTATION, taking the upper limb first, with the head and neck, and proceeding from the extremity towards the trunk.†

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* If the artery on which the operation is performed be found, when exposed, to be extensively diseased, three courses are open. In aneurisms of the extremities, the safest course would be to amputate; in most other cases the operation would most likely be completed; while in some the case would be abandoned to nature. Under the head of ligature of the innominate, a remarkable instance of the good result of the latter course will be mentioned. The Surgeon must rely upon his own judgment.

† In speaking of the ligature of arteries, it has been found impossible to

ANEURISMS IN THE FORE-ARM.

Aneurisms diminish in frequency as the vessels diminish in size; hence the disease is very rare in the fore-arm; indeed is hardly ever seen except as the result of accident.* Very lately, however, I was enabled, through the kindness of Mr. De Morgan, to see a case of aneurism of the upper part of the ulnar artery among his patients at the Middlesex Hospital. In this instance, as I suppose would usually be the case, the whole of the arterial system was diseased, and a loud murmur accompanied the action of the heart.

There can be little difficulty at any time in diagnosing an aneurism in the hand or fore-arm, nor in determining whether it be simply arterial or arterio-venous. The treatment of spontaneous aneurism of these arteries would be exceedingly simple if the disease could be found in a subject otherwise healthy. Digital pressure on the artery leading to the aneurism, maintained by the patient himself as long as he was able for several days, much reduced the size and pulsation of the tumour in the case above mentioned. If this or other forms of pressure failed, recourse would be had to the Hunterian operation; and even in the last resort the old operation would present no great difficulty.

The arteries of the fore-arm far more often require ligature on account of a wound. It is hardly necessary to give minute directions for the performance of such operations as tying the ulnar or radial near the wrist. Common sense would suggest to keep the tendons intact; and this being done, and care taken to avoid mistaking a nerve or piece of fascia for the artery, all the cautions necessary for the operation are exhausted. It is a matter of indifference whether the venæ comites are included in the ligature or not.

If the skin is unbroken, as when the radial or ulnar, or both, are tied for a wound in the palm of the hand, it is merely necessary to make an incision, from an inch to two inches in length, between the tendons which accompany the vessel, divide the deep

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separate the cases in which such operations are required for aneurism and for injury; but as the former class of cases is by far the largest, it was judged best to include the description of all the operations in the present essay.

* Typical examples of such traumatic aneurisms will be found in Ormerod's *Clinical Collections*, pp. 150-1. A case of spontaneous aneurism of the radial artery was under Mr. De Morgan's care at the Middlesex Hospital, and recovered spontaneously. See also Erichsen, op. cit. p. 607.

fascia, which is often strengthened by a distinct thin layer over the ulnar artery; and if the tendon of the flexor carpi ulnaris overlaps the vessel (as is usually the case), draw it inwards, and then the vessel will be exposed by a little dissection, enclosed in its sheath,—the radial accompanied merely by a small filament of nerve, lying above the fascia, which probably will not be seen, the ulnar having its nerve on its inner side.

The radial can be exposed, if necessary, higher up, by a similar operation; but now the muscular belly of the supinator longus requires to be drawn outwards, and the position at which the radial nerve lies against the artery (on its outer side in the middle third of the fore-arm) must be remembered. The different directions of the fibres of the supinator longus and pronator teres must be borne in mind. Their vertical direction will always distinguish those of the former muscle.

To tie the ulnar artery for a wound high up, where it is covered by four of the muscles which arise from the inner condyle, is not an easy matter. When it is required to be tied near its commencement, the ulnar artery may be exposed without any division of muscular fibres. Mr. Guthrie* recommends that an incision should be made through the aponeurosis of the biceps, the pronator teres exposed and drawn towards the ulna, and the dissection continued till the median nerve is brought into view, crossing the artery from without inwards. Then, if it is necessary in order to reach the vessel, part or the whole of the pronator teres is to be divided. In other cases it may be more convenient to divide the muscles from below, an incision being made from the point at which the muscular and tendinous portions of the flexor carpi ulnaris are felt to join, upwards for four inches, and the sheath of the vessels exposed as they emerge from beneath the flexor sublimis digitorum. If the wound be higher up, the division of the latter muscle, and even of those adjoining it, if it be necessary, may be pursued from this point. More or less loss of power will probably follow the division of the muscles, especially if extensive; but this is likely to be transient, and if not, it is a less evil than the loss of the hand. The nerve will probably be the first of the structures around the artery which comes into view.

At *the bend of the elbow* aneurismal swellings are almost always traumatic, and generally are of the arterio-venous class. If the disease be a simple arterial aneurism, whether traumatic or spontaneous, pressure upon the brachial artery is the first resource of the Surgeon. Acute flexion of the limb will very probably succeed, either by itself or as an accessory to the indirect compression. If these means should fail, the natural course, irrespective of any special complication, will be to tie the brachial artery. The treatment of arterio-venous aneurism has been discussed above (pp. 452, 3); we need not, therefore, detain the reader here on the diagnosis or treatment of aneurism at the bend of the elbow; nor does that of aneurism in the arm call for any further remark. We have, then, only to describe the operation on the brachial artery, which may be required for these affections.

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* *Commentaries*, p. 294.

Ligature of the brachial artery for aneurism, or for wound of the lower part of the limb in which the wounded artery cannot be secured, is thus performed. An incision is made, about three inches in length, along the inner margin of the biceps muscle in the middle of the arm; or if that muscle be obscured by œdema, fat, or imperfect muscularity, then in a line drawn from midway between the flap of the axilla to the middle of the bend of the elbow. In making this incision, perhaps the basilic vein will be seen, and should be avoided. The fascia having been divided upon a director, the operator comes down immediately to the packet of vessels and nerves. The internal cutaneous and ulnar nerve lie to the inner side of the artery, and may or may not come into view; or perhaps the external cutaneous will be seen on the other side of the vessels. The difficulty of the operation (which is sometimes considerable) consists in recognising and isolating the artery. What renders this more troublesome is, that the artery, besides being closely surrounded with other structures, does not always maintain the same relation to them. The median nerve is more commonly above the artery, and is the first cord seen below the fascia; but occasionally it will be found under the artery. Again, the brachial artery may not be the only vessel which requires ligature, since another considerable vessel may exist in the neighbourhood (probably a radial artery given off high up, or a vas aberrans), which will have to be sought; it is, however, usually found close to the one first exposed. The veins often encircle the artery with an intricate plexus of anastomosing branches; hence the operation is frequently far less easy than the superficial position of the vessel would seem at first sight to promise. It is true that a little patience and anatomical knowledge will dispose of these difficulties; but they should not be forgotten in deciding the question of treating an anterio-venous aneurism at the bend of the elbow, since, besides the other objections to the Hunterian ligature, it may be said that, as an operation, it will very likely be found no easier, and perhaps much more difficult, than the old operation.

Ligature of the brachial artery is usually very successful, as far as the operation itself goes. It is true that in Porta's statistical table of six hundred cases of ligature of all arteries, ten out of sixty-eight cases of ligature of the brachial artery are said to have died; but in the absence of details we cannot tell whether they died from the effects of the operation. Gangrene is, however, believed to be sometimes a consequence of the application of a ligature to the upper part of the brachial artery, the anastomosis between its branches and those of the axillary being rather scanty (vol. i. p. 679).

Axillary Aneurism.

Axillary aneurism, like popliteal, depends in a large proportion of cases upon injury, more or less severe, to the artery, in the violent movements of the joint near which it lies. This injury may, as it seems, vary from complete rupture of the vessel to some slight contusion or strain, only appreciable by its results. In the former case the aneurism is of the consecutive, in the latter of the false, variety. So far there is little essential difference between axillary and popliteal aneurism. But the different anatomy of the parts occasions a great difference in the curability of these affections. The cellular space of the axilla is so loose and so large, that the tumour may attain a very unmanageable development before any treatment is called in. So that the great advantage which is always obtained in an aneurism by the condensation of the parts around the sac, and the commencement of spontaneous cure in the deposition of laminated fibrin, is less likely to occur in axillary than in other aneurisms; while the growth of the tumour, even if opposed by coagulum in one part, can easily go on in another. Further, in the treatment of axillary aneurism the Hunterian operation is less likely to be successful, since, instead of an artery pursuing a long and comparatively superficial course, without any considerable branches, as the superficial femoral does, the vessel upon which the axillary aneurism is formed is short, deep, and so crowded with large branches, that a ligature can only be applied in close proximity to one or other of them.

It is often said that axillary aneurisms are more difficult to treat than others, because they are so often traumatic. But this seems to me a confusion of terms. A *traumatic aneurism* is more easy to treat than a spontaneous aneurism. What is meant is, that there is so often no aneurism at all, but only a lacerated artery; and a lacerated artery is more, but not much more, amenable to indirect methods of treatment than a wounded one. The presence or absence of a sac determines this point, and this fact is shown by the presence or absence of *pulsation*. I venture to think, with all possible deference to the great authority of Mr. Syme, that in his recent paper on the subject of axillary aneurism,* which has given a new impetus to the discussion of the very interesting question of the treatment of that affection, this point has hardly been made sufficiently plain to the reader, although it may have been present to the mind of the author. Mr. Syme begins his essay with the rather startling avowal that the doctrine, which he had been teaching for more than thirty years, of the superiority of the Hunterian operation to the old mode of treating aneurism, is questionable. But the instance upon which he supports this assertion is one in which, accurately speaking, there was no aneurism at all. The history of an accident, the presence of a large and increasing collection of blood, an arterial bruit, and no pulsation, afford as clear evidence of laceration of the artery, unaccompanied by the formation of an aneurismal sac, as can be obtained; and in such cases, whether they be in the axillary space or the popliteal, the Hunterian operation may be expected frequently to fail; and the only sure resource is to tie both ends of the bleeding vessel. Still the situation of the injury will very much modify the treatment which would be recommended. In the popliteal space the old operation is very difficult and very fatal, while the Hunterian operation is easy. On this account, when the popliteal artery is ruptured, the ligature of the femoral artery has been practised, though unsuccessfully.† But in the axilla, the old operation has been found, in skilful hands, not more difficult than the ligature of the subclavian; it is possible that it may prove less fatal; and it is certain, if not fatal, to cure the disease, which ligature of the subclavian may fail to do. Hence, in a case of effusion of blood in the axilla from accident, where no indications of a sac exist, most Surgeons would agree with Mr. Syme that the ligature of both ends of the injured vessel is a far more rational and more promising proceeding than the ligature of the subclavian, if either operation be requisite. But both are formidable operations, difficult to carry out satisfactorily, and even when performed in the most dexterous manner very dangerous to life. In spontaneous aneurism, or in traumatic aneurism properly so called, *i. e.* in tumours the outlines of which are well defined, the pulsation plainly perceptible, and which can be emptied by pressure if the circulation be commanded, what course should be pursued? Mr. Syme appears to be in favour here also of emptying the sac and tying the artery above and below it, and has performed the operation once successfully. Other Surgeons would prefer to tie the subclavian, in spite of the great mortality with which that operation has been attended.* Perhaps the decision will be best made according to the circumstances of the individual case. If the tumour extend far up, so that the clavicle is much raised, and the neck short and fat, the operation on the subclavian is so dangerous and so difficult that it would be better to operate on the aneurism. In contrary circumstances (*i. e.* where the subclavian triangle is easily accessible and the aneurism buried deep in the axilla), the subclavian may be tied with good prospect of cure. The objection to the old operation, which rests on the probably diseased condition of the artery near the tumour, has less force in this situation than in the popliteal space; since in any case the ligature must be placed near the aneurism.

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* *Med.-Chir. Trans.* vol. xliii.

† See below, Ligature of the Popliteal Artery.

But would not all these affections, viz. ruptured artery, traumatic aneurism, and spontaneous aneurism, be found amenable to milder treatment if it were more perseveringly tried? It will strike the reader of most of the cases of axillary aneurism, in which the details are fully given, how well adapted they seem to have been for the treatment by digital pressure, had that method been known.† At any rate, if moderate pressure on the artery where it crosses the first rib can be made (as it often can), by means of the finger or a pad, so as to control the circulation, the Surgeon is not doing his duty to his patient if he expose him to the risk of a great operation without a careful and patient trial of this safe and often most successful method. If direct pressure by a pad in the axilla, or by bandaging the arm across the chest, appears to assist in controlling the pulsation and bruit, it may be at the same time employed. Instrumental compression is less easy on account of the shape of the parts, and is less likely to be well borne from proximity of the large nerves to the subclavian artery; but it might possibly be advisable to try it in the absence of a sufficient staff of assistants to make pressure with the fingers.

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* Especially in the practice of London Surgeons during the last few years. See below, on Ligature of the Subclavian Artery.

† See a case described by Pelletan, *Clin. Chir.* vol. ii. p. 50. "By raising the shoulder slightly, the subclavian artery could be felt isolated; and by making even slight pressure with the finger, its pulsation and that of the entire tumour could be arrested." So also in Mr. Crossing's case, in *Med.-Chir. Trans.* vol. xvi. p. 344, pressure on the artery as it crosses the rib was easily made; and the same may be said of Mayo's case, ibid. p. 360. I merely instance these cases among many others to which the same remark applies.

If these means fail, one or the other of the operations above discussed must be performed. Mr. Syme thus describes the operation which he performed on the case of ruptured axillary artery on which he first practised the *old operation:* "Chloroform having been administered, I made an incision along the outer edge of the sterno-mastoid muscle, through the platysma myoides and fascia of the neck, so as to allow a finger to be pushed down to the situation where the subclavian artery issues from under the scalenus anticus, and lies upon the first rib. I then opened the tumour, when a tremendous gush of blood showed that the artery was not effectually compressed; but while I plugged the aperture with my hand, Mr. Lister, who assisted me, by a slight movement of his finger, which had been thrust deeply under the upper edge of the tumour and through the clots contained in it, at length succeeded in getting command of the vessel. I then laid the cavity freely open, and with both hands scooped out nearly seven pounds of coagulated blood, as was ascertained by measurement. The axillary artery appeared to have been torn across; and as the lower orifice still bled freely, I tied it in the first instance. I next cut through the lesser pectoral muscle, close up to the clavicle; and holding the upper end of the vessel between my finger and thumb, passed an aneurism-needle, so as to apply a ligature about half an inch above the orifice."*

Mr. Syme adds the important remark, that the extreme elevation of the clavicle occasioned by the great effusion in the axilla, which rendered the artery so inaccessible from above, facilitated this proceeding from below. It was no doubt the same circumstance, of the great depth at which the third part of the subclavian was situated, which rendered it necessary to make an incision over it through the deep cervical fascia before effectual pressure could be made on it; a precaution which ought to be taken in all similar cases.

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* *Med.-Chir. Trans.* vol. xliii. p. 141.

Ligature of the axillary artery after the Hunterian method. The axillary artery is sometimes, though rarely, the subject of operation for aneurism in the arm, the result usually of injury. This operation has been much decried, on the supposition that the necessary proximity of large branches to the ligature would surely lead to secondary hæmorrhage. We have, however, as above noted, the high authority of Mr. Guthrie, and others, for saying that this apprehension is exaggerated. The depth at which the artery lies, and the necessity for cutting through a mass of muscle to expose it, form another, but not a very powerful, objection to the operation, which seems, notwithstanding this, to have been often effected without much difficulty. Chamberlaine* tied the axillary artery just below the clavicle, by a horizontal incision parallel to the lower edge of the bone, commencing about three fingers' breadth from the sternal end of the bone, and terminating about an inch from the acromion. "A second incision of about three inches in length was made obliquely through the integuments over the deltoid and pectoral muscles, meeting the first nearly in the centre. Then the clavicular origin of the pectoralis major was separated from the bone, and the artery brought into view by removing the fat and cellular membrane." The only difficulty experienced was in passing the needle, in consequence of the depth of the cavity and the struggles of the patient. It was accomplished by passing an eyed probe under the vessel, the blunt end first, as I understand the account. The patient made a good recovery. Roux† appears to have succeeded in tying the artery above the coracoid process, by an incision parallel to the course of the vessel, between the deltoid and pectoralis major, without dividing any muscular fibres; but his description is not very full. Most Surgeons would think that the greater room and better view of the parts obtained by the division of the muscular fibres would be a great advantage, and would therefore prefer the former method.

In both these operations the artery is sought from above; an operation which Mr. Guthrie vehemently condemns.‡ The operation which he proposes to substitute is one by which the artery is sought from below, which would of course be the preferable operation if the lower part of the artery (that below the pectoralis minor) is to be operated on, and by which Mr. Guthrie says that any part of the artery can be exposed, and the whole vessel traced up to the first rib, if required. An incision three inches long is to be made over the course of the artery upwards from the lower edge of the pectoralis major, and perpendicular to the course of its fibres. These having been divided, a full view of the axilla and its contents is obtained. If the operation is done for a wound, the bleeding mouth of the artery will be seen by relaxing (if necessary) the pressure which, in such a case, will have been put on the subclavian. Mr. Guthrie says, that "the finger introduced into the upper part of the wound would enable the operator to divide the pectoralis minor muscle if necessary, or to draw it upwards; when the artery, vein or veins, and the plexus of nerves, might be traced up to the first rib without difficulty." Nevertheless, in any operation on this artery, the large vein which lies in front and to the thoracic side of the vessel (sometimes, as Mr. Guthrie hints, double), the numerous large nerves which surround it, and the great quantity of branches which are given off from the artery, and which give off large and numerous vessels towards the inner and front parts, where the operation must be conducted, will occasionally prove embarrassing to the most dexterous operator, though in other cases, as in those above referred to, the Surgeon may have the good fortune to escape them.

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* *Med.-Chir. Trans.* vol. vi. p. 128.

† Op. cit. vol. ii. p. 133.

‡ *Wounds and Injuries of Arteries*, p. 54.

Of the success of this operation, no sufficient data exist to enable us to judge; it appears, however, both from published cases and *à priori* reasoning, that little danger of gangrene exists if the artery be tied above the origin of the subscapular, since that artery anastomoses so freely with branches of a higher origin (posterior and supra-scapular), that the blood is most readily conveyed around the ligature. Secondary hæmorrhage is more to be apprehended, and we may conjecture that diffuse suppuration in the loose cellular tissue of the axilla would often ensue.

I will not detain the reader with any remarks in this place upon the consequences of wound of the trunk of the axillary artery, as distinguished from those which follow the division of one of its large branches near the trunk. The persistence of pulse at the wrist or in the brachial artery is the main feature in the diagnosis; the extent and the advance of extravasation of blood the circumstance which decides the necessity of cutting down on the wounded vessel.*

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* See John Bell's *Surgery*, Charles Bell's ed. 1826, vol. i. p. 416.

Ligature of the subclavian artery in the third part of its course may be thus effected. The patient is to be laid down on the sound side; the arm should be depressed as far as the tumour will allow, in order to draw the clavicle as much as possible out of the way of the artery; the skin of the neck should be pulled down into the chest by the fingers of the operator's left hand, while he makes an incision down to the bone along the prominent part of the clavicle from the edge of the sterno-mastoid to the trapezius. The skin is now allowed to retract, when the incision will lie above and parallel to the clavicle. In this way the external jugular vein, which here dips below the clavicle, will be avoided, and may be drawn with a blunt hook inwards or outwards (the former will generally be found more convenient) during the rest of the proceedings. If the muscles approach near to each other, the sterno-mastoid ought to be partly cut away from the clavicle.

If the patient be stout, or the clavicle much pushed upwards, so that the artery lies at a great depth, it is advisable to connect the transverse incision with one running upwards from its inner end, and dissect the flap outwards.* The cervical fascia must now be cautiously divided on a director to the extent of the wound, commencing from the outer edge of the sterno-mastoid, when the knife may be laid aside, and the parts separated by means of the finger, assisted by the point of a director or other blunt instrument. The finger of the operator is now passed into the 'subclavian triangle,' a small space bounded by the omohyoid muscle above, the clavicle below, and the sterno-mastoid at the inner side. Lying somewhat parallel to, but deeper than, the sterno-mastoid is the scalenus anticus muscle, which must always be carefully sought and traced down with the fore-finger into the first rib. When the point of the finger is placed upon the ridge on which this muscle is inserted into the rib (and which terminates on the inner border of the bone, in a very perceptible tubercle), the artery will be felt immediately under the finger. The other structures contained in this triangle are two branches of the thyroid axis, the transverse cervical and supra-scapular, the veins accompanying them which empty themselves into the external jugular, the brachial plexus of nerves, with some small branches, and finally an absorbent gland. If the transverse cervical artery should be divided, it will be tied without difficulty. The supra-scapular is usually below the clavicle, and is not seen. It did, however, come into view in Dr. Warren's case,* and it was not without difficulty that he was enabled to avoid it; which, as Dr. Warren remarks, it is important to do, both on account of the difficulty that might be experienced in securing it, and because it is an important agent in the collateral circulation. Should either of the veins, or even the external jugular, be much in the way, it may be tied with two ligatures and divided. The gland may be removed without scruple if necessary.† Much care is required to separate the artery from the lowest cord of the plexus, which lies so close to it that it often derives pulsation from the artery, and appears to be a part of it. This mistake is more liable to be committed when the artery is so deep as not to be easily brought into view. It is on this account that it is of so much consequence in these cases to keep the finger carefully on the anterior scalenus muscle, since the artery is more easily recognised by its position with respect to that tendon than by any thing else.

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* Or a flap may be formed by an angular incision projecting beyond the sterno-mastoid muscle, and this flap dissected inwards. Skey, *Operative Surgery*, 1st ed. p. 220.

This operation varies much in difficulty. On the dead subject, or in the living when the person is thin and the parts natural, nothing is more easy; on the contrary, when the clavicle is driven upwards, is greatly curved, as in persons accustomed to manual labour, and the patient stout and muscular, it is one of the most difficult of all the operations on arteries. In these latter circumstances, the artery lies at the bottom of a deep cavity liable to be filled with blood oozing from the many small vessels which will probably be divided in such a case, and the parts cannot be distinguished. It is not wonderful, therefore, that such operations occupy much time, and sometimes terminate in disaster. Two successive cases of Dupuytren's are on record;‡ in one of which every thing went on favourably; while in the other the operation occupied an hour and forty-eight minutes, and on the death of the patient, four days afterwards, it was found that the ligature had been thrust through the vessel, and included one of the large nerves of the brachial plexus, along with half the artery. Another accident to which the operation is liable in complicated cases, is an injury of the pleura, or disturbance of the subserous cellular tissue which connects that membrane to the first and second parts of the subclavian artery. Thus, in a case of much difficulty operated on by Dr. Warren in America,§ the air rushing into the chest with a whistling sound gave evidence of the infliction of a wound on the pleura. The patient nevertheless recovered. Mr. Aston Key* considers that pleurisy and the inflammation of the subserous cellular tissue leading to abscess in the anterior mediastinum will be found to be the most common causes of death in this operation, —an opinion which the statistics quoted below go far to support; and points out the necessity that there is, on this account, for not meddling if possible with any part of the vessel except that which lies immediately on the rib, by which means such an injury to the serous membrane or subserous tissue will be avoided.

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* Infra cit.

† See a case by Mr. Crossing, in *Med.-Chir. Trans.* vol. xvi. p. 340.

‡ See Quain's *Anatomy*, ed. 1848, vol. i. p. 504.

§ *Med.-Chir. Trans.* vol. xxix. p. 32.

That ligature of the subclavian artery should be a very fatal operation, when performed for axillary aneurism, will surprise no one who considers the conditions under which it is performed. In the first place, the procedure resembles Anel's operation almost as much as Hunter's.† Hence suppuration of the sac from loose formation of clot, and secondary hæmorrhage from disease of the artery, may be anticipated. Again, the ligature must be placed in the immediate vicinity of large branches. Then again, the deficient formation of laminated clot is further favoured by the absence or loose structure of the aneurismal sac, and by the want of resistance in the parts which surround it (see p. 470). For these reasons the sound cure of the disease is less probable, and suppuration in the sac far more common in axillary than in other aneurisms; and if to these sources of danger those above noticed, which result from the anatomy of the parts, be added, we shall have, I think, a satisfactory explanation of the high mortality of the operation.

In Norris's table‡ of the statistics of this operation, sixty-nine cases have been collected in which the operation was performed for various causes. The result was most disastrous: thirty-six recoveries against thirty-three deaths; a mortality little less than what is supposed to prevail after amputation at the hip-joint. The few cases recently operated on in London, and reported in the *Medical Times and Gazette*,§ have turned out still more unfavourably; out of six cases two only have recovered. Porta's table of the published cases gives a more favourable account, since out of seventy-four cases twenty-seven only are reported to have died; but as Norris's and Porta's tables were both published in the same year, and as the thirty-three deaths in the former table did certainly occur (for the references to all the cases are given), it is clear that Porta must have missed some of the fatal cases. On the other hand, it is quite possible that Porta may have had access to some successful cases which were unknown to Norris; but the Italian tables not being accompanied by references, as the American are, it is impossible to say how many of Porta's seventy-four cases correspond with Norris's sixty-nine. The most favourable view of the case would be that which would assume that Porta had merely missed six out of the thirty-three fatal cases, and had tabulated all the rest. Now, adding these to his list would give thirty-three fatal cases out of eighty, a mortality of 41·25 per cent. It may safely be said, then, that the average mortality of ligature of the subclavian artery for all causes, and in all cases of hospital and private practice, town and country, taken indiscriminately, is considerably above 40 per cent.

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* *Med.-Chir. Trans.* vol. xiii. p. 8.

† It differs indeed in principle from Anel's,—so far as Anel's method can be said to have any principle; for as the aneurism may be seated below the acromio-thoracic artery, an anastomotic arch may continue the circulation through the sac after operation; but this cannot be calculated on.

‡ *Amer. Journ. Med. Sc.* 1845, vol. x. p. 13.

§ Vol. ii. 1856; vol. i. 1860.

As to the causes of this mortality, we get no information from Porta; out of the thirty-three deaths in Norris's table, five are unaccounted for; of the remaining twenty-eight, nine were caused by hæmorrhage, six by gangrene, five by sloughing or suppuration of the aneurism, five by intra-thoracic inflammation, one by exhaustion, one by effusion on the brain, and one by 'inflammation.'

These facts, as well as the theory of the matter, certainly tend to exhibit ligature of the subclavian artery as one of the least promising of all the surgical operations, and must dispose Surgeons to try the method recommended to them by Mr. Syme in any case in which that procedure does not appear too dangerous.

Aneurism at the Root of the Neck.

This is one of the most formidable diseases which can occupy the attention of the Surgeon; both the diagnosis and treatment are surrounded with difficulties that are usually found insuperable. The proximity of the heart is the cause of the greatest difficulty. It is exceedingly difficult to distinguish whether the bruit is limited to the tumour, or is propagated into it from the cardiac valves; whether the pulsation is limited to the neck, or extends also into the thorax; and whether one only of the large vessels is implicated, or whether others of the great arteries in the neighbourhood, or the whole trunk leading from the heart, may not be diseased and dilated. Then in the treatment, the proximity of so great a stream of blood has hitherto prevented the successful application of a ligature upon the innominate or the first part of the subclavian, for the cure of aneurism situated above the axilla; and the atheromatous deposit, which generally, when it exists at all in these large arteries, involves their whole calibre to a very great extent, has sometimes even prevented the Surgeon from tying the artery after he has exposed it; and the probability of the existence of this state of the vessel renders it always a hazardous matter to attempt an operation.

First, as to diagnosis. The aneurismal nature of the swelling does not usually admit of any doubt; for though here, as elsewhere, malignant tumours springing from the bones may derive pulsation from their own vessels, or tumours of any kind from proximity to the arteries, such sources of ambiguity are less common than in other parts of the body. Reference may therefore be made on the head of diagnosis between aneurismal and other tumours, to what has been said in the section on Diagnosis, and to what follows upon Abdominal Aneurism. But it is often a matter of great importance and of great difficulty to discover whether the aneurism involves the subclavian artery, or the root of the carotid, or the innominate, or more than one of these vessels, or the aorta as well. Mr. Wardrop* lays down as a rule by which aneurisms of these several arteries may be diagnosed from each other, that when the disease affects the root of the carotid, it will present itself first in the small triangular space between the heads of the sterno-mastoid muscle; whereas when the innominate is the seat of disease, it will generally be found on the tracheal, and when the subclavian is affected, on the cervical, side of that muscle. These observations can, however, only apply to cases seen in the earliest period of the disease; and their deceptiveness even in such cases is shown by the fact, that out of the few cases cited by Mr. Wardrop, one† proved to be of the innominate artery, which ought, according to his rule, to have been of the subclavian; but though the place of the first external appearance of the aneurism is not decisive as to the part of the artery from which it springs, it is a symptom of considerable importance, and should always be carefully noted, when it can be clearly ascertained. Another important symptom is the character of the pulsation in the branches of the carotid and subclavian. If the pulse in the brachial or radial, or that in the upper part of the carotid or the temporal, be materially less on the affected than on the sound side, we have some reason for believing the parent trunk (subclavian in one case, carotid in the other) to be affected; and in the opposite circumstances to be unaffected. But neither conclusion is free from some uncertainty. The growth of aneurisms in the cellular tissue of the mediastinum and root of the neck is so free, that instances have been observed of aneurisms of the arch of the aorta causing compression of the subclavian or carotid, without any disease of those vessels;* while on the other hand, if the aneurism approaches the tubular shape, the pulse may be unaffected in the branches, though the trunk is extensively diseased. Again, the influence of the anomalous distributions which so often affect the branches of the aorta is not to be forgotten.† Possibly some assistance to the diagnosis may be obtained by a careful consideration of the other organs compressed by the tumour. Thus pressure on the great veins will lead to lividity, or even a permanently cyanotic condition of the extremity‡ (hand and fore-arm, or face and scalp); pressure on the recurrent nerve, to laryngeal symptoms; on the phrenic nerve, to spasmodic action of the diaphragm; on the trachea, to stridulous respiration, &c.; but much caution is necessary in estimating these symptoms, which are common to thoracic aneurisms as well as cervical.

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* Op. cit. p. 83.

† Case of Gordon, p. 104.

It will be seen from this extremely imperfect sketch, how difficult it is to determine, when an aneurism is situated low at the root of the neck, what or how great a part of the arterial tube is involved. The importance of a precise diagnosis consists in the fact that three great operations are recommended for such aneurisms, and that their applicability depends entirely on the limitation of the disease. If the subclavian or carotid were alone involved, a ligature applied to the innominate artery would be analogous to the treatment adopted in other parts of the body. If the aneurism were seated far down the subclavian on the right side, it might be possible to tie the first part of the artery itself. If the root of the

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[*] See cases by Allan Burns and A. Cooper, in Burns *on the Surgical Anatomy of the Head and Neck*, 1844, pp. 60 et sqq.

[†] I have seen a case in which, from other symptoms, there was no difficulty in diagnosing an aneurism of the arch of the aorta; but one circumstance was difficult to account for, viz. that while the pulse in the right carotid was unaffected, that in the right wrist was imperceptible. After death, that anomalous distribution was found in which the right subclavian is the last branch of the arch. Passing between the aneurism and the spine, it had been compressed, while the carotid was unaffected.

[‡] Wardrop, op. cit. p. 162; Ogle, in *Path. Soc. Trans.* vol. x. p. 103; Bellingham *on Diseases of the Heart*, p. 601; Allan Burns, op. cit. p. 68.

carotid alone were implicated, a ligature on the distal side of the tumour (known as Brasdor's operation) might prove successful. In aneurism affecting the innominate artery, it has been proposed to extend this method, and tie both the subclavian and carotid; while if the arch of the aorta were diseased, no prudent Surgeon would think any operation justifiable.

Assuming that the question of performing any of these grave operations is not entertained till a patient trial of judicious medical and dietetic means has been made and failed, and that a thorough examination of the chest has given reasonable assurance of immunity from disease of the heart, lungs, and aorta, I will endeavour to state as succinctly as possible the conclusions to which I have been brought by observing a few cases, and reading the account of a good number.

I. The ligature of the innominate artery is an operation which has hitherto only precipitated the fatal result impending over the disease, and which appears to afford less prospect of cure than the methods of general treatment which have been above indicated. But if these are obviously insufficient, it may in appropriate cases recommend itself to some Surgeons. It should never be performed, however, unless the artery can clearly be felt healthy behind the sterno-clavicular joint;* or the tumour is so plainly limited as to afford a very reasonable hope that it will be found so. In cases of tubular enlargement of a long tract of artery in the neck, it is worse than useless to expose an artery which will probably be found so diseased as either to prevent the operator from the attempt to tie it, or to give way and occasion fatal bleeding within a few hours if it is tied.†

II. The ligature of the first part of the right subclavian artery is an operation which cannot be described in more favourable terms than that of the innominate, as far as its results go; but the indications are, perhaps, rather less perplexing, since a clear space ought to exist between the tumour and the trachea. Viewing, however, the anatomical difficulties of the operation, the doubt that must always exist whether the artery will be found healthy enough to unite as firmly as is necessary to bear the impact of so great a column of blood, and the great liability to secondary hæmorrhage from the neighbourhood of large branches, the operation seems so unpromising that most Surgeons would prefer the plan by manipulation devised by Mr. Fergusson, or galvano-puncture, dangerous and uncertain as these measures must be allowed to be.

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* If the shape of the bones or joints is altered, it is clear that the aneurism arises in the thorax.

† See below, Ligature of the Innominate Artery.

III. Brasdor's operation for securing the artery on the distal side of the tumour is applicable, and applicable exclusively, to aneurisms affecting the lower part of the common carotid artery; in which, from the equality of the radial pulse on the two sides, the distinct limitation of the tumour, the freedom from œdema of the arm and hand, and the absence of murmur in the aorta or subclavian, there is reason to believe that the affection is confined to the common carotid. In such cases, it would be reasonable to commence the treatment by applying digital pressure to the artery, in the position in which it is intended afterwards to tie it.

IV. In discussing the general question of Brasdor's method, I will give my reasons for believing that it is inapplicable to cases in which it would become necessary to secure the subclavian as well as the carotid.

In the sections which describe the treatment of aneurism by manipulation, by coagulating injections, and by galvano-puncture, the reader will find sufficient data to guide him in forming an opinion as to the propriety of using these measures in any given case of aneurism in the neck.

Brasdor's method will be found described on a subsequent page, together with other operations on the common carotid artery. It remains only to describe the operations on the first part of the subclavian and on the innominate artery.

In order to secure the *first part of the right subclavian artery*, as in the operation on the innominate, the root of the carotid is to be exposed and traced down to the bifurcation. The external incisions and superficial dissection are therefore the same for both operations. An incision should be made along the upper border of the clavicle, a director passed under the sternal border of the sterno-mastoid muscle, and the whole or the greater part of the muscle separated from the sternum and clavicle. An incision should also be made upwards along the inner edge of the muscle, and the whole flap containing the divided muscle should be reflected outwards. The sterno-hyoid and sterno-thyroid muscles now come into view, and may be drawn aside with a blunt hook, or cut across. This will expose fully the sheath of the carotid vessels—the internal jugular vein on this side inclining away from the artery so as to leave an interval in which the pneumo-gastric nerve is to be found. If now the operator desires to secure the first portion of the subclavian, he must remember that the only part of it sufficiently free from important relations to admit of the operation is the small portion bounded by the pneumo-gastric nerve on the inner side, and the thyroid axis with the phrenic nerve on the outer side. The former nerve therefore is to be taken as the guide; and, the carotid artery having been traced down to the bifurcation of the vessels, the subclavian is to be followed outwards till the pneumo-gastric nerve is recognised by the finger. The ligature will then be most readily passed with a probe curved abruptly, or a needle more bent than usual, introduced from before backwards.

If, on the contrary, *the innominate* is to be tied, the operator must follow down the line of the carotid artery into the thorax, when he will find the end of the vessel behind the sterno-clavicular joint, and must get the ligature around it as best he can,—perhaps the most difficult part of the whole operation, since great veins lie close to the artery, the slightest wound of which may give rise to fatal hæmorrhage, and the parts are probably quite out of sight.

On the dead subject, the innominate may be reached without any such extensive dissection, by exposing the root of the trachea with a sufficient incision, and running the finger down it into the thorax, where the artery will be felt crossing the air-tube obliquely; but in the living body I should think the greater freedom and better view of the parts obtained by the division of the muscles at the root of the neck would render the operation above described preferable.*

The innominate is said also to have been reached from the front, by removing the end of the sternum and the sternal end of the clavicle. In this case (under the care of Dr. Cooper of San Francisco†) the upper end of the innominate artery itself was diseased, and the aneurism affected also the subclavian and carotid. The ligature was applied, it is said, only three-quarters of an inch from the arch of the aorta. The patient survived five days, and his death is attributed by the operator to disease of one kidney; but as nothing is told us about the condition of the ligature, or of the tied artery, or of the aneurism, we cannot form any very precise idea of the progress of the case.

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* It is usual in speaking of the ligature of the innominate artery to describe various contrivances for carrying a ligature round it. I have not found on the dead subject that they are superior to the simple aneurism-needle, nor have I seen any case in which they have been used on the living. Mr. Syme, in speaking of the ligature of the common iliac artery, says that, in his judgment, "the simplest form of needle is the best." *Obs. in Clinical Surgery*, p. 169.

† *Amer. Journ. of Med. Sc.*, Oct. 1859.

All the cases in which the innominate artery has been tied have proved fatal, either from secondary hæmorrhage or from inflammation of the thoracic viscera; but in the two first cases in which the operation was undertaken, the patients lived so long as to show the possibility of recovery; Mott (the original operator) having lost his patient on the twenty-sixth, and Gräfe on the sixty-seventh day.* Two remarkable operations are on record in which the artery was exposed, but was found so diseased that the Surgeon did not venture to put the ligature round it.† In one of these (Mr. Porter's) the disease was afterwards cured spontaneously, and in the other (Mr. Aston Key's) the patient lived much longer than usual after the operation.

The operation on the first part of the subclavian has also been hitherto uniformly fatal, but has been so seldom performed, and will probably in future be so much avoided, that it is hardly worth while to discuss the seven cases which are on record, and which may be found mentioned in Erichsen (op. cit. p. 593). In the same place may also be found discussed Mr. Fergusson's proposal for the treatment of aneurism at the root of the neck which resists less heroic measures, viz. to amputate at the shoulder-joint, trusting that the (distal) ligature of the axillary artery on the face of the stump would cure the aneurism now that the limb is removed, and so no need exists for a collateral circulation. The suggestion has not been acted on. The operation must be a most dangerous one to a patient labouring under disease of the great vessels, and the cure of the disease by it highly doubtful.

BRASDOR'S METHOD OF TREATING ANEURISM.

Brasdor was, it is said, the first to propose the operation which has ever since gone by his name, viz. the ligature of an artery affected by aneurism on the distal side of the tumour, or that farthest from the heart, instead of the usual plan of tying it between the heart and the tumour. Brasdor, however, has left no written account of his proposition, nor did he ever put it in practice. It was renewed by Desault, and he has left us a notice of it in his works.* The first person to act upon the suggestion was Deschamps, in a case of femoral aneurism; but his operation was undertaken on such mistaken principles, and was conducted so unsuccessfully, that little use can be made of it. Sir Astley Cooper† tied the femoral artery below an aneurism in the groin, which appeared to him to have extended so far up as to render the application of a ligature above the tumour impracticable. It seems, however, from the terms in which this operation is spoken of, that it was only intended as a temporary expedient, and that Sir A. Cooper expected from it merely such a diminution in the size of the tumour as would render it afterwards possible to apply a ligature in the ordinary way. In this he was disappointed, for the tumour continued to extend upwards, and burst under the peritonæum.

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* Mott's operation, and the particulars of the post-mortem examination, will be found in Gräfe and Walther's *Journ.* vol. iii. p. 569, and Gräfe's, ibid. vol. iv. p. 587.

† Crisp, op. cit. p. 206. The same thing was done, according to M. Broca, by Post of New York.

With the resources that modern Surgery possesses, and, it may be added, with the knowledge we now possess of the very grave dangers attending on ligature of the large vessels, such operations as those above alluded to would be universally repudiated. There is no such reasonable probability of curing an aneurism of any large artery of the limbs by distal ligature as would justify a Surgeon in exposing his patient to the risk of the operation.

There is, however, one situation in which the operation has been successfully performed, and in which it will be perfectly justifiable to repeat it, at least until some more certain and safe means of cure can be suggested; viz. in aneurisms of the carotid artery at the root of the neck. Mr. Wardrop‡ was the first to show the practicability of this proceeding; and he operated successfully on a carotid aneurism of recent origin in a lady aged seventy-five. To him also must be conceded the merit of showing the difference in principle between the operation as practised upon the carotid and upon the arteries of the limbs. The difference depends simply upon the fact that no branches are given off by the carotid artery in any part of its course; so that, for this purpose, the whole of the vessel may be regarded as part of the aneurismal sac, and a barrier at any part of the artery will stop the circulation through the tumour.

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* *Œuvres Chir.* vol. ii. p. 568.

† Hodgson, op. cit. p. 301. Mr. James of Exeter performed a similar operation on the patient in whom he afterwards secured the aorta, and attributed to the distal ligature of the femoral a certain amount of diminution of the tumour. *Med.-Chir. Trans.* vol. xvi. p. 1.

‡ *Med.-Chir. Trans.* vol. xiii. p. 217.

This at least is the case if the aneurism be not situated so near to the subclavian (on the right side) as to share in the circulation of that vessel; but such a tumour would be almost as much an aneurism of the subclavian as of the carotid. On account of his success in this instance, and his work written to recommend this form of operation,* Mr. Wardrop's name is frequently associated with the method as it is now solely applied, viz. to carotid aneurism.

In the *American Journal of the Medical Sciences*, vol. xiv. p. 22, will be found a table by Dr. Norris of fifteen cases in which the carotid artery was tied on this principle.† Of these fifteen, four are admitted to have died of the immediate effects of the operation; and to this number the third case in the table‡ ought certainly to be added, and perhaps the sixth also. At any rate, we shall probably not err much in representing the mortality of Brasdor's operation on the carotid artery at one-third of the number of cases. Of the fifteen cases, four only are said to have been cured by the operation. All of them appear to have been aneurisms of the carotid, unless one should be excepted (No. 5), in which the innominate was thought to be affected; but as this case recovered, the diagnosis was of course not absolutely confirmed.§ If we take these statistics as being correct, which we are obliged to do in the want of more extended experience, it is abundantly plain that the risk of the operation is counterbalanced by a rational probability of success only when the aneurism is seated upon the carotid itself, and does not share in the pulsation of the subclavian. The above amount of success is, however, quite enough to justify the adoption of the method in any such case, where the attempt to tie the artery on Hunter's principle would be impracticable or even attended with unusual danger.

One circumstance, which seems to occur pretty generally though not universally in these cases, testifies very strongly to the activity of the efforts of nature to cure the disease. It is, that the pulsation in the tumour is usually not increased, but, on the contrary, often much diminished, by the ligature of the vessel beyond it. In almost all the cases related in Mr. Wardrop's book, the tumour was observed to diminish both in size and pulsation immediately after the operation; a result which could only have been due to the rapid increase in size of the branches below the tumour, by which the course of the stream of blood was diverted from the aneurism.

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* *On Aneurism*, London, 1828.

† Of which six were for aneurism, supposed to affect the carotid only; in the remainder, the innominate was thought to be the seat of the disease, though it is plain, from the dissection of cases in which death took place, that in some at least the arch of the aorta was diseased.

‡ Mr. Lambert's, quoted from Wardrop *on Aneurism*.

§ The last case operated on in London was under the care of Mr. Lane. The operation was unsuccessful, as the aneurism burst into the lung. Cooper's *Surg. Dict.* 8th ed. 1861, vol. i. p. 215.

Aneurisms of the innominate artery have also been treated in the same way, but, as far as I can discover, without success.* Nor can this be a matter of surprise. The plan adopted is, to tie the two branches of the artery, the common carotid and subclavian, by two different operations. Now, the ligature of the right subclavian in the first part of its course is only less formidable and dangerous than that of the innominate artery itself; and it can hardly be expected to succeed upon a patient who has already been exposed to so severe an operation as tying the common carotid. Otherwise there is no mechanical reason why the treatment should not be successful, provided the Surgeon can be sure that he ties the subclavian between the tumour and the origin of its great branches, for should the mouth of so large an artery as the vertebral, thyroid axis, or internal mammary be left opening out of the tumour, the vessel will probably enlarge to such an extent as to carry on the circulation through the aneurism as effectually as the original trunk. Hence the treatment is beset with so many difficulties and risks, that most persons would prefer the chance of a spontaneous cure under proper medical and dietetic management, if the tumour is not on the eve of bursting. If it is, perhaps the above operative plan may recommend itself to some Surgeons; but it is a desperate expedient.

There is indeed a case† in which both arteries (the subclavian in the third part of its course) were tied, though at an interval of two years, and where the patient is said to have recovered from both operations, and died three months after ligature of the subclavian, of pleurisy. The aneurism was filled with dense organised coagulum, except a channel the usual size of the innominate artery. This, however, can hardly be considered a satisfactory case of cure.

Old operation for carotid aneurism. The treatment of aneurism at the root of the neck, at least when it follows a wound, has been lately successfully carried out by Mr. Syme on the old method, by laying open the tumour and searching for both ends of the vessel. An abridged account of this daring operation is appended; the reader, however, can have no idea of the risks and difficulties of such a proceeding without perusing the fuller account in the original, and even then his idea will be but a faint and imperfect one.

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* I should regard Wardrop's case (op. cit. p. 66) as an instance of benefit (and only of benefit) derived from a combination of Valsalva's treatment with the ligature of the third part of the subclavian. The most recent case I have heard of occurred in the practice of my friend Sig. Ordile of Naples, who related it to me.

† Fearn, *Lancet*, 1836-7, vol. i. p. 129; 1837-8, vol. ii. p. 763; and 1838-9, vol. i. p. 437.

The operation performed by Mr. Syme may be thus summarily described.* The patient had been stabbed in the root of the neck about two months before, and an aneurism had formed, connected with the lower part of the left common carotid. This had been advancing rapidly, under compression applied to the tumour, so that it was necessary to do something. Mr. Syme made a small opening into the pulsating tumour with a bistoury, and then passed in his finger so as to plug the puncture, and felt about till he got upon the spot where pressure controlled the pulsation, and where, therefore, the opening lay. Keeping this point firmly compressed, he laid the sac freely open, and sponged out the clots. A smooth serous surface was exposed, with no trace of artery or vein. The skin and sternal portion of the sterno-mastoid having now been divided by a transverse incision (pressure being still kept upon the opening with the finger), the edge of the slit in the artery which lay under the finger was caught with catch-forceps, and the vessel drawn towards the trachea; it was then carefully scratched with a knife, till the arterial coat was brought into view on the external edge, and a ligature passed round it above the aperture. The same proceeding was repeated below the opening; and now the finger could be withdrawn without the tremendous gush of blood which had before followed its displacement.

It is clear that such an operation as this can be successfully performed (that is to say, performed without instant death resulting) only by a Surgeon who possesses a large share of that fertility of resource and dexterity in operating which Mr. Syme showed in so great a degree in this case. On the general question, as to whether a case like the above ought to be treated on Brasdor's plan, or as Mr. Syme treated it, it would be rash to affect to give a positive opinion; much would depend upon the confidence of the Surgeon in himself. If he felt able to carry out to a successful conclusion so difficult an operation, he would probably imitate Mr. Syme's practice; if not, he might try the distal ligature of the carotid. Should Brasdor's operation fail to check the progress of the tumour, the old operation might be tried, and even a faint prospect of life might remain to the patient from an attempt made to secure the artery after the aneurism had burst.

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* *Observations in Clinical Surgery*, p. 154.

The above operation indicates so clearly the steps that should be taken in securing the carotid on account of a wound, that no further description of that proceeding is necessary.

ANEURISMS IN THE UPPER PART OF THE NECK, THE ORBIT, AND THE CRANIUM.

Aneurisms above the root of the neck will be found to affect either the common carotid just at its bifurcation, or the arteries of the orbit or cranium. The diagnosis in either of the two former situations can generally be established satisfactorily; but few things are so difficult as to distinguish from each other the various diseases which may cause pressure on parts of the brain, or disturbance of the cerebral functions.

The occurrence of dilatation at the upper end of the common carotid artery in a slight degree is natural; and this natural dilatation is comparatively often so far increased that an aneurism results. It is an old observation, that the carotid is the only form of surgical aneurism which is equally frequent in both sexes, if it be not even more common in women. The diagnosis of aneurism situated in any part of the neck, above that portion of the carotid which lies in the immediate vicinity of the subclavian, cannot present any especial difficulty if the sac is formed and the pulsation distinct.[*] The proximity of the tumour to the air-passages and to the nerves which supply the larynx may cause dyspnœa, hoarseness, or even loss of speech, nausea, and perhaps impairment of appetite. There will also be giddiness, and trouble in the head; and perhaps pain, numbness, or other nervous phenomena over the head and face.[†] These symptoms call for decisive and efficient surgical treatment.

Aneurisms situated within the orbit are usually supposed to be of the 'anastomotic' variety; but the evidence on this point is far from conclusive. Mr. Busk[‡] has shown that many, at any rate, are of the ordinary traumatic variety; and Mr. Nunneley, in his paper on the subject, which gives the result of the most extensive experience in this particular which has fallen to any individual, since no less than four cases have been under his own care, goes so far as to question entirely the correctness of the common opinion, founded on Mr. Travers's case; and believes that all the aneurisms have been of the ordinary spontaneous or traumatic kind, except those which have spread into the orbit from a nævus of the face.* Whether all the cases have been so or not, the general correctness of Mr. Nunneley's opinion is not to be impugned, that *most* of these cases (and probably Travers's among them) were common aneurisms.† Both the symptoms and the history prove this. Mr. Nunneley's arguments are these: aneurism by anastomosis comes on gradually, generally in early life, as a result of the growth of a congenital nævus; aneurism of the orbit very suddenly, often as the result of a blow, and almost always in advanced life:—aneurism by anastomosis occurs in the subcutaneous tissues; aneurism of the orbit generally in the deepest part of the cavity:—aneurism by anastomosis involves all the neighbouring vessels, arteries and veins, in active disease; aneurism of the orbit is generally limited to a single part, or if the neighbouring vessels are dilated, they seem only enlarged from obstruction:—ligature of the trunk of a vessel leading to an undoubted aneurism by anastomosis is an extremely unsuccessful operation; in aneurism of the orbit, a very successful one:—finally,‡ the cases dissected have turned out to be common aneurism.§

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[*] A case of ruptured artery is mentioned on p. 352, in which much difficulty was at first experienced in forming a diagnosis.

[†] See the account of Sir A. Cooper's case, *Guy's Hospital Reports*, vol. i. p. 53.

[‡] *Med.-Chir. Trans.* vol. xxii. p. 133.

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* Haynes Walton (*Surg. Diseases of the Eye*, 2d ed. 1861, p. 230) relates a case of congenital tumour protruding the eye, and causing slight pulsation and "an arterial souffle not heard on the other side." Crying greatly increased the protrusion, and the vascularity of the conjunctiva, which was always considerable. It was diagnosed by himself and colleagues to be aneurism by anastomosis. The carotid was tied with perfect success.

† This is important, since the success of Travers in tying the carotid has been used, under the assumption that his case was aneurism by anastomosis, to enforce the recommendation of a similar operation in cases of aneurism by anastomosis on the scalp,—an operation by which several lives have very probably been sacrificed.

‡ See Mr. Nunneley's account of the dissection of the only case out of the four under his care which proved fatal, in *Path. Soc. Trans.* vol. xi. p. 8. I may observe, that the whole of the ophthalmic artery and its branches are represented in this drawing as dilated, which brings the case somewhat near to cirsoid aneurism. I do not understand how Mr. Nunneley accounts for this dilatation by saying that it is the result of obstruction. Such obstruction might act on the artery behind, but surely not in front of the aneurism. Guthrie (*Operative Surgery of the Eye*, p. 168), in referring to the dissection of a case, merely says that he found "true aneurism of the ophthalmic artery of both sides."

§ *Med.-Chir. Trans.* vol. xlii. pp. 183-4.

The diagnosis of anastomotic aneurism in Travers and Dalrymple's cases rested on the presence of soft compressible thrilling tumours in various parts of the eyelids, which presented a more distinct pulsation when pressure was made on them. It is most probable that these were merely collections of veins enlarged by pressure, and transmitting pulsation from the aneurism lying beneath them.*

Aneurism may also affect either the internal carotid artery, in its bony canal or in the cavernous sinus, or one of the arteries of the brain. The symptoms of aneurism affecting the internal carotid in the sinus are mainly of three kinds: (1) the symptoms of aneurism; (2) the symptoms of pressure on the orbital nerves; (3) those of disturbance of the cerebral circulation.

(1) In a well-marked case the symptoms of aneurism will come on rapidly, very likely after a blow or other injury; there will be, perhaps, a sharp crack heard, followed by a sawing or rasping noise. This sound will be perceived by the stethoscope applied to the head or neck, more plainly on the affected than the sound side, and will cease at once on making pressure upon the common carotid on the side of the disease. If the disease is limited to the part of the artery contained in the sinus, no tumour will be perceptible externally, nor any pulsation or fulness in the orbit. (2) The first symptom of pressure upon the orbital nerves is either internal strabismus, from paralysis of the sixth nerve;† or ptosis, with external squint and dilated pupil, from pressure on the third nerve;‡ or loss of sensation in the parts supplied by the supra-orbital nerve.§ Sight on the side of the disease is usually not affected; sometimes, however, objects are seen double, or there is more or less indistinctness of vision, the consequence, probably, of the dilatation of the pupil. These symptoms of pressure on the orbital nerves may exist all together, or in various combinations. (3) The symptoms of cerebral disturbance do not seem greater in a moderately early case of this affection, than in an aneurism of the common carotid: headache, giddiness, inability to stoop, frightful dreams, &c. There is no pressure on the brain, since the growth of the tumour is opposed by the dura mater. It seems possible that the aneurism might grow through this membrane, and cause softening of the base of the brain; but I have not met with such a case.

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* The most recent and complete information on this subject will be found in a paper by Mr. Hart, *Lancet*, March 15, 1862, on a case of arterio-venous aneurism in the orbit cured by ligature of the common carotid artery.

† *Assoc. Journal*, 1855, p. 1067. ‡ *Path. Soc. Trans.* vol. xii. p. 61.

§ Id., ibid.

With such a combination of symptoms, then, the diagnosis of aneurism may reasonably be made; and the case may justifiably, in the present state of our knowledge, be treated as such. Such a case was the following, which occurred under the care of Mr. Coe of Bristol and Dr. Swayne.* The patient was a woman, aged fifty-five. The disease was attributed to a blow five months before, after which she complained of a buzzing and beating noise in the head, which at the time of the account she likened to the puffing of a steam-engine, heard more distinctly with the left than the right ear, and accompanied by a continuous sound, like low thunder, emanating from a spot near the posterior superior angle of the right parietal bone. She could not lie down in bed, and was troubled with frightful dreams. There was no bruit in the heart or great vessels, but a most distinct one in the neck and over the whole surface of the head, especially the left petrous bone; pressure on the right carotid had no influence over the sound, but on the left carotid caused it to cease immediately. On auscultating the right carotid carefully, its pulsation could be separated from the bruit, which was also louder on the left side. The left eye squinted a little, and she saw double, one thing by the side of the other. No tumour could be perceived externally. The left carotid was tied on Dec. 11, 1851; the bruit ceased; a gentle continuous murmur followed (ascribed by Mr. Coe to the flow of blood through the tumour from the anastomosing branches); this ceased in about five hours, and all the symptoms subsided. The woman was cured, and, as I am informed by Mr. Coe, remains well at the present time. But a case which occurred recently in London, under Mr. Bowman's care,† must be kept in mind, as showing that the diagnosis cannot be regarded as certain. In that case many of the above symptoms were present—severe pain in the head, after an accident, aggravated by stooping; disturbed sleep; a beating noise in the head, compared to a steam-engine; a loud bruit, synchronous with the pulse; troubled vision; protrusion of the globe of the eye, and pulsation in the orbit strong enough visibly to lift the fingers. The carotid artery was tied, and the bruit ceased, but recurred, though not so loud, eight days afterwards. The patient died of secondary hæmorrhage, when it was found that the arteries were quite healthy; and the only diseased appearance was in the ophthalmic vein, cavernous, circular, transverse, and superior petrosal sinuses, which were filled with coagula. The pressure on the carotid artery in the sinus must have produced the bruit, the obstruction to the return of blood by the veins of the orbit, the protrusion of the eyeball, and the congestion of the parts around it; while the pulsation perceptible in the orbit is attributed by Mr. Hulke, to whom we are indebted for the report of the case, to the same cause. "Each diastole of the ophthalmic artery," he says, "must have been attended by a general momentary increase of the whole quantity of blood in the orbit, because its exit through the ophthalmic vein was cut off, and the resisting bony walls of the orbit could permit a distension in front only."

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* *Assoc. Journal*, 1855, p. 1067.

† Streatfield's *Ophthalmic Reports*, April 1859.

The symptoms of aneurism of one of the small arteries at the base or in the substance of the brain, are as yet quite obscure. Physicians and physiologists are busily endeavouring, by experiment and the study of cases, to decide how, from the symptoms of limited pressure or other limited lesion, to determine the precise part of the brain affected. Even if this great difficulty were got over, how are we to decide whether such limited injury depends on pressure by an aneurism, or by a tumour of a different kind, say a scrofulous tubercle?* The rapidity of the onset of the symptoms, and the variation in their severity, occasioned by different states of the circulation, seem the only peculiarities which point to aneurism, and they are excessively doubtful and delusive. We have, indeed, no means at present of diagnosing cerebral aneurism, unless a bruit could be found; and in looking over a number of cases I do not find any mention of this symptom having been looked for. In Dr. Ogle's case, however, the patient was herself conscious of "a sawing noise" in the head. It seems, therefore, that in similar cases the head should be carefully auscultated, though it is very likely that the small size of the aneurism and of the vessel on which it is seated, and the mass of soft, ill-conducting parts that lie over it, would prevent bruit from being heard.

Treatment of these aneurisms. Aneurisms situated in the carotid triangle of the neck must be treated on ordinary principles, digital pressure on the trunk of the vessel being used in cases where the symptoms are not very urgent, combined, perhaps, with moderate pressure over the tumour; in severer cases, or on the failure of these measures, the common carotid artery must be tied. Besides the ordinary medical and dietetic means, and excluding a very few cases in which the Surgeon might be tempted to try the effect of galvano-puncture, there are only two methods of treatment available for aneurism within the cranium or orbit, *i. e.* pressure on, or ligature of, the carotid artery. The use of digital pressure has been successful in aneurism of the orbit, under the care of Gioppi and Vanzetti (pp. 323, 4); and there can be no reason why it should not succeed in such a case as that of Mr. Coe's. It need not give much annoyance to the patient, and can be carried on as long as the disease is either receding, or even not advancing. When its failure is certain, the common carotid artery should be secured.* It would at first sight appear better, as the disease is seated upon the internal carotid, to secure that vessel; but it does not seem that any advantage is obtained by leaving the stream of blood in the external carotid unobstructed. In orbital aneurism, the free anastomosis might reproduce the disease; in aneurism at the base of the brain, the danger of softening of the brain is as great after ligature of the internal as of the common carotid; while no harm ever comes from stopping the circulation through the branches of the external carotid. So that, as the ligature of the common carotid artery is an easier and safer proceeding, it is rightly performed.

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* See, in *Med.-Chir. Trans.* vol. xlii. p. 403, a paper by Dr. Ogle, in which he carefully endeavours to point out how, from the symptoms presented in the case there related, he might have diagnosed lesion limited to the pons Varolii. Even had he done so, however, he would have referred the lesion to pressure by a scrofulous tumour, while it was in reality an aneurism of the anterior cerebellar artery.

The ligature of the common carotid in an ordinary case of aneurism, where the patient is not very stout, the aneurism not situated near the root of the neck, but towards the angle of the jaw,† and the parts healthy, is generally an easy operation. The artery can be felt, in any person not extremely stout, pulsating on the anterior edge of the sterno-mastoid muscle, at the level of the cricoid cartilage, where it first becomes superficial, after having been crossed by the omohyoid muscle—the apex of the carotid triangle. This is accordingly the place of selection for the ligature. The operation is thus performed: If the sterno-mastoid muscle is perceptible, an incision about two and a half inches in length (in a moderately stout adult) is to be made along its anterior edge, the centre corresponding to the level of the cricoid cartilage; and after the cervical fascia has been divided, which may be done freely, as no important parts are endangered, the edge of the sterno-mastoid ought to be exposed. This having been drawn a little outwards, the finger should be passed into the wound, to feel for the trachea, when the artery will be felt lying between the muscle and the air-tube. The operator must now carefully separate the cellular tissue from the sheath which covers the artery, and endeavour to raise the descending branch of the ninth nerve, which generally lies upon the sheath. This nerve, when exposed, is to be held aside with a blunt hook, while a small opening is made in the sheath of the artery; and the vessel having been cleaned by the usual manipulations, the ligature is to be passed around it from without inwards, great care being taken to keep the point of the aneurism-needle quite close to the artery, so as to avoid wounding or tying the pneumo-gastric nerve. The operator must remember that the descendens noni nerve sometimes lies within, instead of upon, the sheath of the vessels; so that, when it has not been met with after a sufficient search, the artery may be tied without seeing it; but in this case even more than common care should be bestowed in examining the vessel as it lies upon the aneurism-needle, in order to make sure that this nerve has not been included. In the course of the dissection some bleeding may occur from the sterno-mastoid artery, which is usually the descending branch of the superior thyroid, and may prove annoying to the operator unless the vessel be tied.

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* In Mr. Hart's paper he attributes to the previous use of digital pressure, and consequent dilatation of the collateral arteries, the entire immunity from all symptoms which his patient displayed after ligature of the carotid artery; an immunity which was certainly remarkable.

† This observation of course applies still more forcibly to the cases in which the disease is situated in the orbit, and therefore quite away from the parts operated on; but in a case where Brasdor's method was applied, I remember seeing considerable difficulty experienced by the operator from the circumstance that the artery had been displaced backwards by the pressure of the tumour at the root of the neck.

When the aneurism is situated lower in the neck, the operation becomes more difficult, since it is necessary to cut through a considerable mass of muscle. The artery is here situated under cover of the sterno-mastoid with the sterno-hyoid and sterno-thyroid muscles. An incision must be made along the course of the artery, viz. the line joining the sterno-clavicular articulation with the point midway between the angle of the jaw and the mastoid process, and this incision may be joined by another running outwards. The inner, or sternal, portion of the sterno-mastoid is to be cut across, and this being drawn outwards with a broad retractor, it will be generally possible to draw the two other muscles inwards, otherwise they must be divided. The sheath of the vessels will now be exposed; but there will in all probability be several large veins lying over it, which descend from the thyroid body, and on the left side of the neck the internal jugular itself inclines considerably to the front of the artery towards the thorax. The wound also is very deep, and the vessel is probably rendered relatively deeper by the projection of the tumour. Still, by keeping the course of the vessel steadily in view, and by feeling for the trachea internally and the transverse processes of the vertebræ behind, the artery must be reached. Great care, however, is necessary in opening the sheath and cleaning the artery, since the vessel itself can hardly be brought fairly in view. The proximity of the stream of blood in the innominate artery on the right side is a great, but not a fatal, objection to this operation. Porter* has tied the right carotid successfully within half an inch of the bifurcation of the innominate.

The operation of tying the common carotid artery used to be looked upon as one of the most successful in Surgery; and perhaps, if we regard the important parts whose circulation is interfered with, that opinion may seem relatively justified; but absolutely the mortality is now known to be very considerable.

In the paper on the subject by Dr. Norris above referred to, the result of 149 cases in which the carotid was tied has been tabulated. Of these, 54 died, or more than one-third; an amount of mortality much exceeding that of any of the commoner operations of Surgery.†

The chief causes of death after ligature of any large artery, excluding those affections which depend on previous disease and the complications which follow on any grave surgical operation, are secondary hæmorrhage and gangrene. The former is comparatively rare after ligature of the carotid, in consequence of its long course without branches. Still it is not perhaps so uncommon as is generally supposed, since among the fifty-four fatal cases in Dr. Norris's table, hæmorrhage is noted as the cause of death in fifteen of them, and it may have been present as a symptom in many of those which recovered.

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* Sup. cit.

† Dr. Norris's paper, however, includes all classes of cases, tabulated as, I. Operations for aneurisms (Hunterian); II. For wounds; III. In or previous to extirpation of tumours; IV. For cerebral affections; V. For erectile tumours of the orbit, scalp, &c.; VI. On Brasdor's method for aneurisms. We may consider separately the cases in which the artery is tied for the cure of a disease, by excluding classes II. and III.; and then Dr. Norris's table (rejecting one case, in which it is doubtful whether the artery was really tied) gives us exactly 100 cases, with a mortality of 33. It seems, therefore, fair to say, that the ordinary ligature of the common carotid for diseases involves a risk which may be represented on an average by a mortality of one-third. Possibly where the disease is remote, the chance of recovery is greater. In Mr. Hart's paper, above referred to, out of twenty cases where the carotid was tied for aneurism in the orbit, only three died.

Gangrene shows itself principally in the form of softening of the brain. The external parts of the head and neck are never, as it seems, affected with gangrene; a fact which is readily accounted for by the free anastomoses and liberal supply of the vessels of the face and neck. The anastomoses in the brain are indeed even more abundant; but then the brain appears to be more in want of a constant and equable supply, and to tolerate badly the withdrawal for even a short space of so large a quantity of blood as is brought to it by this great artery. Twelve of the fifty-four fatal cases in Dr. Norris's table seem to have died from some symptoms referable to the brain, which, however, are very variously stated; 'convulsions,' 'apoplexy,' and 'inflammation' of the brain, being the more common headings. It may be allowed us to doubt, in the absence of more exact information, whether this 'inflammation' was not, in most cases at any rate, atrophic softening.

Either the external or internal carotid may be tied for a wound of the vessel itself in the carotid triangle. The operation does not essentially differ from that on the common carotid. An incision made in the same line but higher up will lead down directly upon the internal carotid. The external carotid is nearer the middle line, and would be recognised in an operation by the edge of the digastric muscle and the hypoglossal nerve crossing its course. But the circumstances which would justify ligature of either of these arteries, except for wound, must be very rare. In aneurism affecting the internal carotid in the cranium, I have already stated the reasons which would lead me to prefer the ligature of the common carotid. I have not met with any account of cases of true aneurism of the branches of the external carotid, except traumatic aneurisms of the temporal artery, which are usually under the control of direct and indirect pressure, otherwise the temporal artery itself may be easily tied either by the Hunterian or the old method. But cirsoid or anastomotic aneurisms of the branches of the external carotid are very common, and, upon the failure of other methods, it might be thought advisable to tie the external carotid artery. If so, it would be perhaps better to secure the arteries on both sides at the same operation. In wounds of arteries derived from the common carotid, occurring in inaccessible situations, the common carotid artery itself has usually been tied, and with frequent success. This operation has called down the vehement censure of Mr. Guthrie in cases of wound of the internal carotid from the fauces; but the operation by which he proposed* to secure the two ends of the bleeding internal carotid, after having divided and turned up the ramus of the lower jaw, has not yet been demonstrated to be practicable on the living body, and it seems hardly worth while to describe an operation which will probably never be put in practice.. The usual method of securing the common carotid is recommended in the essay on INJURIES OF THE VESSELS, vol. i. p. 691. We may, however, allow that every exertion should be made to secure the bleeding artery itself in any case, and that it is only where that operation is plainly impossible that it is justifiable to resort to so uncertain a measure as tying the trunk-vessel.

Any of the branches of the external carotid which arise in the carotid triangle may require to be tied on account of a wound; but no special directions appear necessary. The diagnosis of the particular vessel injured would be impossible till the parts had been exposed, when the bleeding would be the only sure guide to the mouth of the artery. But the lingual artery may require ligature on account of disease. Mr. Moore has lately communicated a paper to the Royal Medical and Chirurgical Society, in which he relates a case where he secured this vessel in a case of cancer of the tongue.

The operation is thus performed: The patient being in the recumbent position, with the head drawn over to the sound side, and a small pillow under the neck, an incision is made obliquely downwards and backwards, about two and a half inches in length, its centre being opposite the end of the great cornu of the hyoid bone. The superficial parts being divided, the point above mentioned should be kept in view, and the lingual nerve exposed. The artery runs deeper than the nerve to gain the deep surface of the hyoglossus muscle, and must be carefully searched for in the cellular tissue. This operation is more difficult than the description would seem to imply. The reason is, that as the parts are unsupported except by the loose and soft wall of the pharynx, the vessel is constantly retreating from the operator, who must be careful in conducting his dissection, for fear of wounding the pharynx. As the vessel is tortuous, it is necessary to keep close upon the end of the great cornu of the hyoid bone,—the only sure guide to it. In the dissection, a large vein, the internal jugular or one of its branches, may be exposed.

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* *Commentaries*, p. 256.

REGIONAL SURGERY OF ANEURISMS IN THE ABDOMEN AND LOWER EXTREMITY.

The Foot and Leg.

As in the upper extremity, so still more in the lower, aneurism hardly ever affects the arteries below the great hinge-joint, except as the result of accident. Spontaneous aneurism, it is true, is not unknown in the leg; but it is extremely rare. The museum of St. George's Hospital contains a specimen of aneurism of the posterior tibial artery cured by ligature of the femoral; and other scattered examples of these aneurisms may be found in pathological collections. These aneurisms, like those in the fore-arm, will hardly ever be found originating spontaneously except in subjects affected with extensive disease of the heart and arteries; and appropriate position, bandaging, and digital pressure on the first accessible artery above the tumour, will be the appropriate means of cure for these, as for those. If this treatment should fail, it will be for the Surgeon to consider whether his patient has sufficient vital power to survive the ligature of the femoral artery, and whether the disease is grave enough to justify the risks by which that operation must be attended.

Pressure and proper position will, in all probability, stop bleeding from any vessel in the foot; but it is possible that a traumatic aneurism in the foot or near the ankle may necessitate the ligature of one or other of the tibial arteries; these vessels, however, are much more often tied on account of wound. The *ligature of the anterior tibial* may be thus performed. If the vessel requires to be tied above the middle of the leg, it will be found very deeply placed on the interosseous membrane, between the thick muscular bellies of the tibialis anticus on the one side, and on the other of the external longus digitorum above, and extensor proprius pollicis below, tightly bound down by the fascia of the leg. In order to reach it on the living subject with any tolerable facility and in any tolerable time, the intermuscular space must be hit, and the vessels exposed without any groping about among the muscles. This can be easily done on the dead subject, but on the living the operation must be one of considerable difficulty. An incision, proportioned to the fatness of the leg (about four inches might be taken as a moderate length), is to be made in the line joining the head of the fibula with the middle point between the two malleoli. The skin and superficial fascia being separated from the deep fascia, a whiter line running down the latter will be seen marking the intermuscular space.* This is to be slit up to the same extent as the original wound, and the muscles drawn forcibly apart with broad retractors, and the ankle flexed in order to relax them. Then, at the bottom of the deep interval, the nerve will come into view, and below it the vessels will be found inclining to its inner side. Even in the dead subject there is often considerable difficulty in getting a ligature round the anterior tibial (especially if the operator wishes not to include the veins, which, however, in the living body would be a matter of indifference); and this difficulty would be much increased in practice by the fact that the operation would probably be undertaken on account of a wound, and that the neighbouring parts would be obscured by the extravasated blood, the muscles perhaps lacerated, and the cavity in which the vessel lies so deep that the bleeding, by which alone the artery could be recognised, would also constantly obscure and hide the bleeding orifice. Hence in such cases great pains should be taken to endeavour to restrain the bleeding by graduated compresses, or by digital pressure in the wound, before resorting to an operation which may fail, and if it does so, may cost the patient his limb.†

In the lower part of the leg, where the muscles have ended in their tendons, and where the vessels are supported on the tibia, there will be much less difficulty in finding the artery; but the line of incision is the same, and the same muscle (tibialis anticus) serves as a guide to it, the artery lying on its outer side.

The remarks above made, as to the propriety of endeavouring, if possible, to avoid operating on small arteries so deeply seated as those of the upper part of the leg, apply to the posterior tibial, and still more forcibly to the peroneal, which, however, has been successfully tied on account of wound by Mr. Guthrie;‡ but no special instructions are needed for this operation, which consisted merely in making a very long incision in the middle line of the calf (seven inches in length, with its centre at the wound), dissecting down towards the fibula, turning out the clots, and looking for the bleeding point; in doing which it was necessary to cross the incision by one running towards the fibula, so as to turn down two little flaps. The bleeding point having been seen, a sharp hook was struck into the tissues below it, and the whole was tied up in two ligatures above and below the part whence the bleeding proceeded. As the patient recovered, it was, of course, impossible to affirm that the peroneal was really the artery which had been tied.

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* Guthrie recommends that the foot be alternately flexed and extended to bring these muscles in view more distinctly.

† I am informed by Mr. Moore, that in a case where he had occasion to tie the anterior tibial for a wound, he found much assistance to discovering the position of the vessel from tracing back its branches, which are given off in considerable numbers to the muscles around it.

‡ *On Wounds and Injuries of Arteries*, 1846, p. 35.

Ligature of the posterior tibial in the upper part of its course, where it lies under the deep fascia which separates the mass of muscles forming the superficial layer of the calf from those which form the deeper layer, can be effected in one of two ways. The first of these consists in making an incision of suitable length (say six inches) along the posterior edge of the tibia, and having divided the fascia, pulling the gastrocnemius away, cutting the soleus off the tibia to the extent to which it is exposed, and thus coming down upon the deep fascia which covers the artery, and which is to be divided with the usual precautions, in order to search for the vessel lying below it. This way of making the incision, which is the old method of reaching the vessel, is condemned by Mr. Guthrie as "difficult, tedious, bloody, and dangerous;" and he proposes to substitute for it a vertical incision along the middle line of the calf, over the position of the vessel, through the gastrocnemius and soleus muscles. Mr. Guthrie himself never had the opportunity of carrying out this suggestion; but it was put in practice by Mr. Arnott in a case where he tied the artery for a wound.*

In that case, indeed, the position and direction of the external wound would have indicated some such course; but Mr. Arnott has put on record his preference for Mr. Guthrie's method, and advises that it should be followed if it should ever become necessary to tie the posterior tibial on account of aneurism situated low in the leg; a necessity which does not seem hitherto to have occurred. Mr. Arnott, however, remarks about his operation what is probably even more applicable to the old procedure. "It is not one which should be undertaken inconsiderately. It requires good light and intelligent assistants. The case which has been described occurred in the daytime; and from what was then experienced, I am disposed to think that it would not have been successfully performed by artificial light, or at least with greatly increased difficulty."† The difficulties which Mr. Arnott experienced were dependent, he says, on the depth of the wound, the pain and cramp on pressure of the divided muscles, and the venous hæmorrhage from concomitant wound of the venæ comites. Of these difficulties, Mr. Arnott rates the first as the least, and the last the greatest. The second would, of course, in the present day be avoided entirely by anæsthesia; but the third must always be anticipated in operations for wound of the artery, since the venæ comites are closely connected to it. Pressure in the angle of the wound from which the bleeding comes must be maintained as much as possible during the operation by the finger of an assistant. The trunk of the femoral or popliteal is of course secured by a tourniquet. An incision is to be made, six or seven inches in length, down the middle of the calf of the leg, including the skin-wound in its centre. The gastrocnemius and soleus muscles are to be freely divided in the course of the wound, and held aside by broad retractors. Now the operator should search carefully for the deep or intermuscular fascia, immediately beneath which the posterior tibial vessels will be found. The situation from which the bleeding comes will point out whether it is the tibial or peroneal. If the latter be the artery wounded, most likely a good part of the flexor longus pollicis must be scraped off the fibula in order to find it, or (as Mr. Guthrie seems to have done) all the tissues around the bleeding point must be included in the ligature. If it be the tibial, it may be exposed with rather less difficulty. Still it is a most difficult operation, as will be evident to any reader of Mr. Arnott's account, although in that case the wound was only recently inflicted, and Mr. Arnott had able assistance at hand. In cases where much blood has been infiltrated into the leg, obscuring all the neighbouring parts, or where the Surgeon is not very much versed in operations, or has to trust mainly to his own hands, it would perhaps be the better course to amputate; but I may be excused for repeating that properly-applied and carefully-graduated compresses, or the prolonged pressure of a finger in the wound, enlarged if necessary, would often render either operation unnecessary. In a recent traumatic aneurism, probably one of the various methods of applying direct or indirect pressure would succeed. If any operation became necessary, most Surgeons would prefer to tie the femoral artery. Some, perhaps (but they would be very few), might treat the case, like a wounded vessel, by the old operation.

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* *Med.-Chir. Trans.* vol. xxix.

† Op. cit. p. 51.

If the posterior tibial artery requires a ligature in the lower part of the leg, the operation is more simple, on account of the less depth at which it lies. An incision is to be made, about three inches in length, parallel to the inner border of the tendo Achillis, and the vessel is to be sought on the outer side of the two large tendons which pass behind the inner malleolus, that of the flexor longus digitorum being the nearest to the vessels. Behind the ankle the tendon of the flexor longus pollicis is on the opposite (external) side of the artery, but in ordinary cases will not come into view.

The popliteal artery has also been tied on account of subcutaneous rupture, unsuccessfully as far as the result of the case went, since gangrene set in on the third day, followed by amputation and death; but no difficulty was experienced in the operation,* which is thus described by the operator:† "Mr. Poland made an incision of from seven to eight inches in length along the course of the popliteal artery, and cleared out much coagulum, and without difficulty found the ends of the ruptured artery lying an inch and a half apart; the upper end seemed to be plugged by coagulum, and was secured by ligature; the lower end seemed to be patent, and was similarly ligatured. The popliteal vein was distinctly seen, and appeared to be uninjured." On examining the parts after the amputation, Mr. Poland found that the knee-joint had been laid open by an extensive laceration of the posterior ligament, a complication which would probably have precluded recovery even had gangrene been averted; and as this same complication was present in three cases successively admitted into Guy's Hospital (the first three in Mr. Poland's collection), the point ought to be carefully investigated during the operation for ligature of the artery, by passing the finger into the deep parts of the wound, where if either condyle of the femur can be felt bare, amputation should be performed.

POPLITEAL ANEURISM.

Although popliteal aneurism is so frequently curable without operation, yet operations for its cure constitute the great majority of those performed for aneurism.‡ The popliteal artery is so frequently diseased because it is liable to strain both in flexion and (though to a much less degree) in forced extension of the joint;§

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* In the only two other cases, however, reported in Mr. Poland's paper, where the artery was sought for, the operation proved impracticable. The femoral artery has also been tied on account of this injury in two cases, but gangrene and death followed in both. Mr. Poland speaks in terms of merited reprobation of the practice.

† *Guy's Hospital Reports*, 3d series, vol. vi.

‡ In the *Med. Times and Gaz.* (supr. cit.) seventy-five cases of ligature of large arteries are reported, of which fifty-one were of the femoral, in almost all cases for popliteal aneurism.

§ Very few sedentary persons, or females, suffer from this disease. In Norris's table, out of 155 patients, five only were females.

also because it is the end of a large tube, convex alternately forwards and backwards, which divides abruptly into much smaller branches, and is supported only by fat, while its branches plunge at once among muscles.

The symptoms of popliteal aneurism are usually quite characteristic.* The attention of the patient is called to the part by the tumour or by pain and stiffness of the limb, or by the pulsation,—very commonly the latter; and on examining the part the Surgeon is left in no doubt of the nature of the complaint. The aneurismal bruit is usually distinct, though cases are sometimes met with in which it is absent. The feeling of the pulsation differs somewhat according as the aneurism is growing towards or away from the joint; that is, according as it is situated on the front or the back of the vessel. The more usual position appears to be at the back of the artery towards the skin of the ham; and then the pulsation is of the usual equable heaving and expansive character. But when the aneurism is growing towards the joint, and the artery therefore is raised upon its posterior surface towards the skin, the pulsation feels much more thrilling, and a distinct line of separate pulsation often marks the course of the vessel. The position of the aneurism also materially influences the probability of complications involving the joint. A large tumour rapidly growing on to the posterior ligament of the knee, must cause considerable irritation in the joint; and synovial inflammation from this cause is a frequent accompaniment of popliteal aneurism. Still further, the resistance to the growth of the sac afforded by such firm structures as the bones and ligaments of the joint soon leads to ulceration, so that such aneurisms are liable to burst into the knee-joint; the symptoms and indications of which event have been pointed out on pp. 358, 411.

The part of the artery affected varies; but the aneurism usually presents in the middle of the popliteal space, and bulges out below either hamstring. On dissection, the opening in the artery is most commonly found near its lower end.

Treatment. The treatment of popliteal aneurism is usually successful, since such tumours partake of the nature of the milder forms of traumatic aneurism, and often occur in comparatively healthy persons. Besides, there is a long tract of artery above the tumour in the most favourable position for compression, and the anastomotic branches come off in tolerable profusion just above the tumour, and enlarge readily.

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* Further observations on the diagnosis of bursal and other tumours in the ham from aneurism will be found in the essay on DIAGNOSIS AND REGIONAL SURGERY.

Before other severer measures are tried, genuflexion ought undoubtedly to be attempted. If bending the knee to its full extent stops the pulsation in the tumour, the best hopes may be entertained of its success. The kind of aneurism most adapted for it appears to be that which is situated on the back of the artery, and has not yet got very near the skin. In a tumour which appears on the point of bursting, it would be imprudent to insist on its trial; nor would it be likely to succeed if the pulsation were unaffected, or even (which seems theoretically possible) increased. Pressure, instrumental or digital, on the femoral artery may succeed when flexion fails, or a combination of the two may appear more efficacious, and is easily arranged. In applying pressure, it is important to remember that the artery changes its relation to the bone in its course down the thigh, and that in order to command the circulation with the least possible force, the pad ought to be directed towards the femur. The method of applying pressure in this situation has been discussed above.

If under the use of pressure the tumour is making visible progress, the femoral artery must be tied; and this becomes still more necessary if the sac have burst; since, if the operation be delayed, the occurrence of gangrene will probably necessitate amputation.

Amputation also becomes necessary on the failure of the ligature, except in some rare cases of recurrent aneurism, when the femoral can be tied in Hunter's canal (see supr. p. 409).

Ligature of the femoral artery. The femoral artery may be tied at three parts of its course: (1) above the origin of the profunda; (2) at the apex or lowest point of Scarpa's triangle; (3) in the canal formed by the tendinous fibres which connect the adductor magnus with the vastus internus. Of these, the last proceeding, that originated by Hunter, is now disused, unless for exceptional cases of recurring aneurism, such as Sir A. Cooper's, above quoted; and the second is the one universally employed in popliteal aneurism; the first being reserved for certain cases of aneurism in the thigh, and as a preliminary to some operations.

The great advantage of Scarpa's operation, for securing the artery just as it is being crossed by the sartorius muscle, is that the vessel is exposed at a point where it is superficial, and therefore easily found; while at the same time it is far from the origin of any large branch. The operation in a natural condition of parts and a patient not very stout is usually easy. If the outline of the sartorius muscle is plainly perceptible, this will perhaps be the easiest and surest guide. Otherwise a line drawn from the centre of the fold of the groin to touch the inner border of the patella when the foot is a little abducted, will mark the course of the vessel. An incision three or four inches long having been made in this direction through the skin and subcutaneous tissue (in which it will be well to avoid any large branch of the saphena vein), the fascia lata will be recognised, and should be divided on a director to the whole extent of the wound. This should expose the inner edge of the sartorius, which must otherwise be sought for by dividing the cellular tissue carefully without going deeper into the wound; and when the muscle is recognised, but not before, the sheath of the vessels is to be sought. It is generally found at once, by drawing the muscle slightly outwards, and the pulsation is felt. A nerve is usually seen in front of the artery, and must be excluded from the ligature. This may be either the internal saphenous nerve or a smaller branch of the anterior crural.* A small opening is to be made in the sheath, and enlarged to such an extent that the artery is fairly exposed; and then the vessel should be so far cleaned as to allow the aneurism-needle to be passed round it without material resistance. The great danger at this step of the operation is lest the vein should be injured, or should be included in the ligature. To avoid the first mistake, great gentleness is required in cleaning the artery and in passing the needle round it; while the second seems impossible if the vessel have been once fairly and cleanly exposed. The position of the vein must be accurately remembered; it lies almost directly behind the artery, inclining perhaps a little to its inner side. Hence we are usually recommended to pass the needle from within outwards. This being so, if the front of the artery have been once cleanly denuded, and the point of the needle have been fairly applied to it, it seems impossible that the needle can be thrust to the deeper side of the vein, without an amount of violence which is never used on the living subject; nor can the needle even perforate the septum which separates the artery from the vein, so as to wound the latter, without more force than is justifiable. If the occurrence of venous hæmorrhage shows that the vein has been punctured,* the bleeding ought to be commanded by pressure, which is not difficult, and the operator must make up his mind either to abandon the operation for the time, and seek the vessel at a higher part of its course after a few days, or (which is perhaps the preferable course) to enlarge the incision upwards, and tie the artery with more care, about an inch above the spot originally selected. The ligature should on no account be tightened in the part where the needle has first wounded the vein, since in this way the thread would be left in the vein to act as a seton, and phlebitis could hardly fail to ensue, and would most likely prove fatal. If the needle have glided round the vessel without any such accident, the next step is to determine that the tissue embraced by it is really the artery, and nothing else. This is easily ascertained by pressing lightly on the tissues raised by the needle, and examining the part with the finger. The pulsation of the vessel will be felt; on making pressure, the beating of the aneurism will cease at once; while, if any doubt exists on that point, the absence of congestion shows that the vein is not included. Nothing then remains to be done except to tie the ligature firmly, and close the external wound with strapping or two or three sutures.

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* A small nerve is often seen on the front of the sheath, but the saphenous nerve itself does not come into connexion with the artery so high up as the usual seat of operation. Where it is in relation with the sheath, it lies rather external to the position of the artery, firmly bound down by a separate layer of fascia, which appears to form a portion of the sheath. Hence, if the sheath is opened only by a small puncture over the inner part of the vessel, the nerve will not come into sight.

In a case of ligature of the femoral artery which is to do well, the warmth of the foot, which is maintained by wrapping the limb in cotton wool, remains slightly above that of its fellow for a few days; the patient lying quiet does not notice the numbness and partial paralysis which would no doubt manifest themselves if he tried to move about; sensation is perfect; the ligature may be expected to fall any day after the first week.†

The chief danger after the operation is from gangrene. In Dr. Norris's statistics,‡ of 204 operations (for all causes), fifty died. Out of these fifty, the cause of death is not stated in four; and of the remaining forty-six, twenty-three, exactly one half, died from gangrene, while hæmorrhage proved fatal in eight cases only; five of the remaining deaths are attributed to phlebitis, one to sloughing of the sac, and the rest to accidental causes common to all operations —tetanus, fever, hectic, pyæmia, &c.

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* Slight arterial hæmorrhage is sometimes observed as the needle is passed round the artery, and stops when the ligature is tightened. It proceeds, in all probability, from the wound of a minute branch near its origin from the vessel.

† The earliest period at which the separation of the ligature has been noted in a successful case, free from hæmorrhage, appears to be the eighth day; but it rarely comes away before the eleventh. In one case it came away on the sixth day, but hæmorrhage occurred. In 91 cases out of 137 it separated before the twentieth day; but it has been known to remain on the vessel up to the sixtieth day.

‡ *Am. Journ. Med. Sc.*, Oct. 1849, n. s. vol. xviii. p. 313.

Hæmorrhage, however, occurred in numerous cases in which it did not prove fatal, having been arrested by pressure. In order to apply pressure effectually to the femoral artery when secondary hæmorrhage takes place, a graduated compress should be fixed very carefully on the wound by means of a presse-artère, or the bleeding point should be commanded by the fingers of a relay of well-instructed assistants. Should these means fail to arrest the bleeding, the external iliac artery must be tied, or the limb amputated, unless the Surgeon choose to cut into the wound, and tie up again the bleeding portion of the vessel. Mr. Erichsen declares himself in favour of the latter mode of treatment. The first is the course most usually prescribed in our surgical works; but it has always (according to Mr. Erichsen) been followed by gangrene. The ligature of the bleeding portion of the artery is an operation which has never yet been carried out, as far as I know, and which would be most likely extremely difficult, from the inflammatory changes and extravasation of blood which have gone on around the vessel. It could only be undertaken as an exploratory measure, preliminary to amputation, if the latter measure should be found necessary. In all cases of severe secondary hæmorrhage, there seems little doubt that amputation is the safest measure for the patient, though it is one to which no Surgeon would willingly resort.

A slight amount of gangrene is not always inconsistent with the preservation of the limb; while of the cases of more extensive gangrene, many are saved by secondary amputation. Six cases of successful amputation are recorded in Norris's table.

Porta's statistics give somewhere about the same mortality* as those of Norris. It may be said, however, that these statistics give an unfair view of the mortality, since many of the operations were performed by the older Surgeons on exploded and unscientific principles; or that successful operations on the femoral artery are so common that they are not considered worth publication. But no such objections can lie against the statistics collected by Mr. Hutchinson* of the cases of ligature of this artery in metropolitan hospitals. Out of fifty cases, sixteen have died, or, in round numbers, one-third. Mr. Bryant's tables of amputation of the thigh at Guy's Hospital for all causes,† with which those collected by the present writer from St. George's Hospital‡ agree in all essential particulars, give a mortality considerably under one-third. So that ligature of the femoral artery seems to have proved more fatal than amputation of the thigh in the practice of London Surgeons during the last few years, taking all cases of each operation indiscriminately.

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* It would be wrong to quit the subject of the mortality after ligature of the femoral artery, without noticing the fact that Mr. Syme tied the artery twenty-three times in succession without any unfavourable symptom (*Principles of Surgery*, 1856, p. 99). Still, in urging this remarkable fact as an argument against the use of pressure, I cannot help thinking that that distinguished Surgeon has been misled by a success which must be exceptional in the practice of any operator, however skilful.

If it be necessary to tie the artery in Hunter's canal, which, however, can only be the case either for wound or after the failure of the common operation, the same line of incision will be made, but lower down; and it will be necessary to divide the muscles freely. Hence the operation is more protracted and bloody, but no important parts are endangered in either. The principal risk is of wounding the vein, or of including it or the saphenous nerve in the ligature.

Femoral Aneurism.

Spontaneous femoral aneurism is regarded, with reason, as a more serious affection than popliteal, since the latter often affects persons whose vascular system is in all other respects sound, while the former gives much reason to suspect a generally atheromatous condition of the vessels, in which case the existence of organic disease of the heart, or of internal aneurism, is exceedingly probable. Every such case, therefore, should be carefully examined with reference to these points before the treatment is fixed. The diagnosis of an aneurism in the thigh can hardly be attended with difficulty. It is conceivable that some doubt might exist as to the vessel upon which it was seated, whether the superficial or deep femoral; but I am not aware that such an ambiguity has really been met with, nor would the doubt have much effect upon treatment. In traumatic cases, the diagnosis between simple and arterio-venous aneurism should be attended to; but enough has been already said upon that point; what follows will refer entirely to the treatment of common aneurism in the thigh. Rest, without any special treatment, has been known to lead to the spontaneous cure of a femoral aneurism;* but it would not be good practice to delay the commencement of more active treatment beyond the day or two which is usually allowed in order to familiarise the patient's mind and body with his novel circumstances, unless the tumour were visibly decreasing in size. In all cases in which the sac has not burst, compression of the femoral in the groin ought to be tried, and will usually succeed, especially if there is opportunity for the careful application of digital compression. Nor if the sac has burst is the case by any means desperate. A careful examination will show whether pressure with the finger controls the further progress of the extravasation; if it does, compression of the femoral may be tried for a day or two, the case being, however, very carefully watched. On the failure of pressure, recourse is to be had to the Hunterian operation, which can generally be effected below the groin, in the first part of the artery; but in cases where the tumour extends higher up, the ligature must be placed on the external iliac. The former operation will be described here, the other being appended to the section on Inguinal Aneurism.

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* *Med. Times and Gaz.* vol. ii. 1856, p. 515, i. 1860, pp. 12, 35, 62, 89, 117.

† *Med. Chir. Trans.* xlii. 70.

‡ *Med. Times and Gaz.* vol. i. 1861, p. 358.

Ligature of the common femoral artery is an operation which is not generally regarded with much favour, and which is, therefore, little practised for the cure of aneurism, inasmuch as the operator generally prefers to tie the external iliac. The reason of the supposed danger of the ligature of the artery in this situation is, the proximity of the ligature to large branches. The epigastric and circumflex iliac on the one side, must come off near the ligature if it is placed close to the fold of the groin; and the profunda on the other, if it is placed lower down. The neighbourhood of these large branches would certainly appear likely *à priori* to lead to secondary hæmorrhage; but some doubt is thrown upon this theoretical conclusion by the experience of the elder and younger Porter, the latter of whom reports three cases fully, and alludes to two others, in which the operation was performed by himself and his father, all of which were successful.† But this operation has not as yet been performed sufficiently often to allow of our pronouncing a confident judgment; and it must be left to the discretion of the operator to select the proceeding which he may think best calculated to save his patient's life. The ligature of the femoral is certainly a far more easy and a less formidable operation primarily than that of the iliac. The artery can usually be felt pulsating; and nothing is necessary except to divide the soft parts over it carefully with a moderate incision, so as to apply the ligature (which should be carried from within outwards) without any exposure of the vein or other parts. The crural branch of the genito-crural or a small branch of the anterior crural nerve may be found running down in front of the vessel, but can be easily avoided.

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* Luke, in *Med. Gaz.*, May 9, 1845.

† *Dublin Quarterly Journ. of Med. Sc.*, Nov. 1860.

Mr. Erichsen asserts,* that out of twelve cases in which the femoral has been tied, only three have succeeded, the others having failed in consequence of secondary hæmorrhage; and thinks that the operation should be banished from surgical practice.

Another objection to which the ligature of the common femoral is exposed is the liability to gangrene, in consequence of the vessel being blocked up above the origin of both of the great nutrient arteries of the limb. The superficial femoral, which nourishes the lower part of the limb, is comparatively easily reinforced after the ligature by its free anastomosis with the profunda artery; but when both these channels are blocked up, the consequent strain upon the collateral circulation is much increased.

In Norris's table, above referred to, the femoral artery was tied twenty-seven times for aneurism in the thigh, with only five deaths; a smaller proportion than that of ligature of the femoral from all causes. Unfortunately, it is not told us in how many of these cases the artery was exposed above the origin of the profunda; which must, I presume, have been the case in some if not in most of them. The omission in so careful a compilation is doubtless due to the inadequacy of the original notes. In Porta's table, eight are said to have died out of sixteen; but no details are given.

INGUINAL ANEURISM.

Pulsating tumours are always to be viewed with some suspicion when they lie in close proximity to any bone possessing a copious diploe. Hence such affections about any part of the pelvis should always be very carefully examined before they are pronounced aneurismal. The records of Surgery abound in instances of tumours in the gluteal and abdominal regions having been pronounced to be aneurism of the large arteries of those parts, when they were really pulsating cancers of the bone; and many of the cases reported by the older Surgeons were obviously of this nature, though the mistake was never discovered, and they stand amongst the list of aneurisms. Such a mistake is less likely to occur in the groin, than about other parts of the pelvis; but the Surgeon should be on his guard here also. A comparison of the pulse in the chief arteries of the two limbs will be of great service, since it is usually altered in aneurism and not in the pulsatile tumour; and the other points of the diagnosis between aneurism and pulsatile tumour should be carefully examined. (See p. 383.)

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* Op. cit. p. 617.

The diagnosis having been made, the question will occur whether the case is a fit one for compression, or whether the Hunterian operation must be performed. Compression on the external iliac, in persons not very fat, can be easily applied by the finger; and numerous instances of the success of digital pressure in this region are recorded (see pp. 422, 4).* In the face of such facts, no Surgeon would be doing his duty who exposed his patient to the great risks of an operation on the external iliac artery, without a well-considered and persevering attempt to cure the disease by pressure, whether digital or instrumental. It is possible, also, that direct pressure upon the tumour may assist in the cure, as it seems to have done in Mr. Luke's case, above referred to; but this should be used very cautiously, if at all, since sloughing of the coverings of the tumour would most seriously complicate the case.

Ligature of the external iliac artery. The operation for securing the external iliac artery is usually regarded as a very successful one; and relatively to the other operations on large trunk vessels, it may be so considered; but the mortality is still very great. Of 118 published cases taken indiscriminately, thirty-three died; a mortality exceeding that of amputation of the thigh.

The operation is performed by making a sufficient incision through the parietes of the lower part of the abdomen, the precise direction of which is not a matter of very great consequence, but which is usually drawn from a little above the centre of Poupart's ligament outwards (so as to avoid the direction of the epigastric artery) to a little internal to the anterior superior spine, from which point it is to be curved inwards, as far as may be thought necessary, towards the umbilicus; or it may lie directly over the course of the artery. The muscles are to be divided to the same extent, care being taken in dividing the lowest strata, until the transversalis fascia is reached. This structure can generally be recognised immediately beneath the muscles, and should be divided in the iliac fossa, not far from the anterior superior spine, upon a director, after a hole has been cautiously made in it. The operator will now find a cellular interval lying above the peritonæum; and that membrane, with the intestines, should be gently and gradually pushed over towards the middle line, until the vessels are seen or felt. The vein, it should be remembered, lies internal to the artery and the genito-crural nerve, or lower down its genital branch, lies on the anterior surface of the vessel. The ligature must, therefore, be passed from within outwards; and if the nerve have been included in it, care should be taken to slip the thread away from under it before the knot is tied. The ligature of this little nerve need not, however, lead to any bad results. The accident which usually happens in this operation is, naturally, the laceration of the peritonæum. It is not necessarily attended with fatal or even serious consequences (see vol. ii. p. 442); but still it should be most carefully avoided.*

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* While these sheets are passing through the press, an aneurism in the groin, of considerable size, and another lower down in the thigh, have been cured, at St. George's Hospital, by the use of mixed digital and mechanical compression; and a case of popliteal aneurism has recently been cured by the flexion treatment, after the ineffectual use of compression for a considerable period.

The points to be chiefly guarded against in the ligature of the external iliac artery are, wound of the epigastric artery, of the vas deferens, or other constituents of the spermatic cord, laceration of the peritonæum, puncture of the external iliac vein or of the circumflex vein, ligature of the genito-crural nerve, and a too free disturbance of the subperitoneal cellular tissue. The wound of the epigastric artery is only probable when the operation is practised from below. The vessel can, it is true, be secured, but the bleeding and loss of time are objectionable; and after it is tied, an important anastomosis is stopped up, and the chance of gangrene increased. The vas deferens also is only endangered in tracing the artery upwards. A knowledge of its position, and its peculiar cord-like feeling, will suffice to make the operator avoid it. The laceration of the peritonæum cannot always be avoided. Great gentleness should be used; and before the operation the patient should have been well purged, in order to obviate any distension of the intestines. The clean exposure of the artery is the best safeguard against wounding the vein or including the nerve. The circumflex iliac vein which crosses the end of the artery must be avoided in the operation from below. A careful selection of the method most appropriate to the case before him will enable the operator to reach the artery with the least possible disturbance of the deep cellular tissue. It is true that it may become absolutely necessary to disturb a large extent of the peritonæum from its cellular connexions; but this should always be avoided as far as possible, since it greatly increases the risk of diffuse inflammation on one or the other side of the serous membrane.

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* In principle, the various operations described on the iliac arteries reduce themselves to two methods, in one of which the artery is reached from below, while in the other it is approached from without or from above, as described in the text. The latter method is easier when the aneurism encroaches upon Poupart's ligament; the former when the tumour is situated lower down, and the whole of the artery may, therefore, be expected to be found healthy. There is little difference between the two plans, except that the operation from below requires a smaller incision, and is less difficult in appropriate cases; but if the artery be pressed back into the pelvis by a tumour extending up into the groin, it becomes much more difficult, if not impracticable, from adhesion between the tumour and the peritonæum. Sir A. Cooper, in describing the operation from below, advises that "the centre of the internal oblique and transversalis muscles should be raised from Poupart's ligament. The opening by which the spermatic cord quits the abdomen is thus exposed, and the finger passed through this space is directly applied upon the iliac artery." The rest of the operation then consists chiefly in scratching the fascia off the artery, separating the latter from the vein, and passing the ligature round it, which Sir A. Cooper directs to be done from without. Mr. Guthrie, however, justly observes, that the vein is less likely to be injured if the point of the needle be first insinuated between it and the artery, and the ligature carried from within outwards. (Guthrie's *Commentaries*, p. 268.)

In Norris's table* of 118 cases of ligature of this artery for all causes, thirty-three died; out of these the cause of death is not stated in one, and in two was unconnected with the operation; of the remaining thirty, thirteen died of gangrene, and three of sloughing of the sac, six of hæmorrhage, two of peritonitis, one of diffuse inflammation, two of prostration, two of tetanus, and one of delirium tremens. In successful cases, the earliest period of the separation of the ligature was the tenth, the latest the sixty-second day. In forty-four cases it came away before the twentieth day, and in twenty-four others before the thirtieth.

Abdominal Aneurism.

Many of the pulsating tumours which are found in the false pelvis are of a cancerous nature; many of those which are undoubtedly aneurismal are seated upon the aorta, too high for surgical treatment. Thus, both the diagnosis and treatment of such tumours demands the most careful consideration. I can add nothing on the general question of the diagnosis between aneurism and pulsatile tumour of bone to what will be found above; and will here merely remark that the points most likely to be marked as distinguishing a tumour of the os innominatum from an aneurism of the iliac or gluteal artery would be the presence of swelling on both sides of the bone, and the appearance of cancer-cells in the urine, together with the equal beat of the pulse on the two sides. It would never be agreeable or advisable to commence an operation on the iliac vessels without having plainly heard the aneurismal bruit. But Mr. Moore's case above referred to (p. 382) shows that even this symptom may be deceptive.

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* *Am. Jour. Med. Sc.* vol. xiii. 1847, p. 13.

As to the treatment of an aneurism in the belly, three plans suggest themselves: the employment of compression to the artery above, the use of medical means only, or the Hunterian operation.* It is only very thin persons, and those of a very placid temperament, who could bear any prolonged compression of the aorta against the spinal column. But in such persons, manual compression of that artery may be, and ought to be, tried. In some very thin persons, the pulsation of the vessel can be controlled without much difficulty by the fingers; but a pad would generally be required, and pressure should be kept up for a short time at frequent intervals, as long as the tumour appeared not to be increasing; the necessary medical treatment being at the same time enforced.

The Hunterian operation for abdominal aneurism may be practised on the common iliac artery, or on the lower part of the aorta. In some cases it may perhaps be possible to secure the upper part of the external iliac for aneurism situated above the groin; but this operation has been already described.

The operations for securing all the iliac arteries are similar in principle, and identical in most of their details. The same incision serves to reach them all,—only to reach the common or internal iliac the incision must extend further upwards, and must be longer, in consequence of the greater depth at which the internal iliac lies, and the higher position of the common iliac. Hence the Surgeon can determine during the operation which vessel he will select, according to the extent of the tumour and the appearance of the artery when exposed.†

In applying a ligature to the *common iliac*, the operator must remember the situation of the large veins which run with the artery of each side; and he must be careful to look out for the ureter, both to avoid including it in the ligature (of which, however, there is little risk), and to avoid doing it any other damage.

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* The old method has been adopted here also; but its results, I believe, have been, and would always be, uniformly fatal.

† Guthrie, *Commentaries*, p. 262.

The common iliac may also be tied by an operation behind the peritonæum similar to that which is used in experimental operations on the lower animals for tying the abdominal aorta.

Sir P. Crampton's case is well known, and his operation is a good illustration of the method of reaching the artery from above the tumour. An incision was made from the end of the last rib obliquely forwards and downwards to the crista ilii, and then curved forwards above and parallel to the crest of the ilium, terminating at the anterior superior spine. The muscles and fascia transversalis were cut through at the bottom of the incision till the subperitoneal interval was reached, and then the peritonæum being held back by the front of the finger, a probe-pointed bistouri was run along the back of the finger, and so by repeated strokes of the bistouri the muscles were divided to the extent of the external wound. Sufficient room was thus obtained to pass in the whole hand, and raise the peritonæum and intestines from the fascia iliaca. The parts were then plainly visible, and the vessel easily secured.*

The artery may also be reached by an incision through the peritoneal cavity, similar to that by which Sir A. Cooper cut down upon the abdominal aorta; but this operation should never be done if either of the others are practicable.

The statistics of the ligature of this great vessel are most gloomy, the recoveries having been only exceptional. In the *American Journal of Medical Sciences* for July 1860, Dr. Stephen Smith has collected all the cases known to have occurred, thirty-two in number,† of which only seven terminated in recovery; and in one case at least the patient appears to have died under the operation. The causes of death were noted in nineteen cases; and it is remarkable that gangrene was the alleged cause in only three instances; the others were, 'exhaustion' eight, hæmorrhage six, and peritonitis two. In successful cases, or cases uncomplicated by hæmorrhage, the ligature may be expected to separate in about three weeks.

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* It is worth while to quote Sir P. Crampton's forcible description. "The parts were unobscured by a single drop of blood. There lay the great iliac artery, nearly as large as my finger, beating awfully, at the rate of 120 in a minute, its yellowish-white coat contrasting strongly with the dark blue of the iliac vein which lay beside it, and seemed nearly double its size. The ureter, in its course to the bladder, lay like a white tape across the artery; but in the process of separating the peritonæum, it was raised with that membrane, to which it remained attached." *Med.-Chir. Trans.* vol. xvi. p. 162.

† Dr. Smith has divided his cases into four groups: 1. for arrest of hæmorrhage in wounds, or in surgical operations, eleven cases, only one of which recovered; 2. for aneurism, fifteen cases, ten deaths; 3. for pulsating tumour mistaken for aneurism, four cases, one recovery; 4. to obviate

Ligature of the abdominal aorta. Sir A. Cooper's case, the first of the five in which the abdominal aorta has been tied, is well known.* The patient was suffering from aneurism, which appears to have involved the left common iliac artery, and some distance of the vessel below it. It had burst through the skin, and the patient was greatly reduced by hæmorrhage. Sir A. Cooper endeavoured, by making a small puncture into the aneurism which he could plug with his finger, to reach the opening of the artery, with a view of tying it on both sides of its communication with the sac—the operation since practised by Mr. Syme. But as he could not reach the vessel by this means, he determined to give the patient the 'only hope of safety' which remained for him, by putting a ligature round the artery above the tumour—the aorta. The operation was accomplished by an incision through the linea alba, three inches in length, its centre corresponding to the umbilicus; the peritonæum was opened to about the extent of the skin-wound; the intestines, which were completely empty,† did not protrude; the finger was passed down between their convolutions on to the spine, where the aorta was felt beating violently. The peritonæum was then scratched through with the finger-nail, and the point of the finger was insinuated below the vessel. The aneurism-needle was then conveyed round the aorta, and the ligature tied. In doing this, great care was necessary, to avoid including the intestine or omentum. Sir A. Cooper's patient survived forty hours; Mr. James's died the same evening. These cases, to say nothing of the numerous instances in which the artery has been successfully tied

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hæmorrhage in an operation in one case, and in an aneurism for anastomosis in the second, two cases, both of which died. It is perhaps hardly presumptuous to say, after this experience of the operation, that most of the cases ought never to have been submitted to ligature; and that the operations in the first class would now be unjustifiable.

* *Surgical Essays*, by Cooper and Travers, vol. i. p. 128.

† Sir A. Cooper adds the remark, that in this operation it is essential to have the bowels well emptied; and the truth of this observation was exemplified in the next case in which the artery was tied, by the great trouble experienced by the operator (Mr. James) in consequence of the tympanitic condition of the intestines. *Med.-Chir. Trans.* vol. xvi. p. 1.

in the lower animals, certainly show the possibility of survival after the operation; and accordingly the operation has been repeated several times,* not, however, on Astley Cooper's plan, but by an operation similar in most respects to Sir P. Crampton's on the common iliac artery; that is to say, by a free incision through the abdominal walls, somewhat far back, carried down to the fascia lining them, then making a cautious division of this fascia to the extent of the wound, gradually pushing over the peritonæum and intestines, and directing the fingers towards the front of the spine, where the pulsation of the great artery will easily be felt. But though it is easy to feel the artery, there is much difficulty in getting the finger round it, and in separating it from the important parts which lie around.

Many most interesting questions present themselves in considering the justifiability of this daring experiment in operative Surgery. Our space will not allow of their adequate discussion; but the main considerations must be summarily stated. *First*, is there really any rational prospect of recovery? One of the patients (Monteiro's) survived ten days, so that it would be rash to deny that there is. Still we must not forget that such an operation is never undertaken except upon a patient in the extremity of a disease probably affecting the whole arterial circulation, one in a very different condition from a healthy animal, or even a healthy man. *Secondly*, allowing the theoretical possibility of recovering, is the practical chance of it ever equal to that of spontaneous cure? Sir A. Cooper's case certainly was one, to judge by his description, in which such a cure was impossible, since he had laid open the tumour in an unsuccessful attempt to perform the old operation; and hæmorrhage must soon have occurred, and could hardly have failed to prove instantly fatal, so that some operation was inevitable. But *thirdly*, is it ever necessary to secure the aorta itself? Mr. Guthrie believes, on the contrary, that when any operation is possible, the common iliac artery above the tumour could always be reached by making the incision on the opposite (sound) side, as if to tie the common iliac of that side, and then passing over from that artery, when it has been found, to the one on the side of the disease.† The old operation might be attempted, but would be very liable to fail, from the fact of the sac passing into the pelvis, and so perhaps pressing the opening of the artery out of sight; or galvano-puncture might be tried in a case which seemed suitable for it. In such desperate circumstances probably any treatment would be unavailing to prolong life; but the risk of doing harm by any treatment is not great, since the patient's life will not last under any circumstances more than a few days. On the whole, however, the natural repugnance of Surgeons to perform great operations which they do not expect to succeed will either banish this altogether from practice, or restrict it to a very few exceptional cases.

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* By Murray, *Med. Gaz.* 1834, vol. xiv. p. 68; Monteiro, *Schmidt's Jahrb.* 1843; South, *Lancet*, 1856, vol. ii. p. 222.

† *Commentaries*, p. 265.

GLUTEAL ANEURISM.

Pulsating tumours in the buttock, of spontaneous origin, are usually found to be of a cancerous nature, and connected with the innominate bone; but aneurism of the gluteal or sciatic artery may occur unconnected with wound. The diagnosis, however, should be very clearly established before the extremely dangerous measures necessary for the treatment of gluteal aneurism are recommended. The points to which principal attention would be directed would be, whether any tumour is present in the iliac fossa; whether the bruit is of the true aneurismal character; whether any bone can be felt in the envelope of the tumour; whether the pulsation resembles that of aneurism (expansive) or that of pulsatile tumour (rapid and heaving); and, finally, whether any signs of constitutional affection can be detected. Mr. Guthrie's case,* however, shows that the greatest experience in aneurism cannot always insure against errors of diagnosis.

If the existence of aneurism appears certain, two courses are open to the Surgeon; viz. to perform the old operation with the precautions against sudden and excessive hæmorrhage which Mr. Syme adopts, or to tie the internal iliac artery. The former course can only be recommended when the aneurism is of traumatic origin, since in that case the artery will be sound, and the wound in it will be within reach; while in a spontaneous aneurism, besides the risk of putting the ligature round an unsound artery (which, under the circumstances, is a minor consideration), the orifice of communication may be within the pelvis, and the old operation absolutely impracticable. Mr. Syme's recent volume† contains an example of each form of aneurism, and each method of treatment, which was successful in both instances. No further description is necessary here of Mr. Syme's method (or revival of Astley Cooper's method) of performing the old operation, as it has been already described on p. 488. I shall, therefore, proceed to describe the ligature of the internal iliac artery.

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* *Med.-Chir. Trans.* vol. xxviii. p. 308.

† *Obs. on Clinical Surgery*, 1861, pp. 165-173.

The internal iliac should only be tied for aneurism of one of its branches, or for a wound within the pelvis in which pressure will not stop the bleeding. In this case, however, the operation, which is one in itself of great danger, should be practised only after very careful deliberation. The artery has been secured in order to stop hæmorrhage from a wound in the buttock; but the practice has been justly censured by Mr. Guthrie.*

The operation much resembles that above described for placing a ligature on the common iliac (see p. 516). Having, by the steps there prescribed, arrived at the lowest point, or bifurcation, of the common iliac artery, the operator must follow down the internal iliac into the pelvis, his finger being laid across the external iliac vessels, which may, if it be practicable, be shielded by a curved spatula from all chance of injury. It is desirable to place the ligature at a distance of about $\frac{1}{2}$-$\frac{3}{4}$ inch below the bifurcation. The vein lies behind the artery. The spot at which the ligature is to be placed having been fixed, the Surgeon scratches the artery free from its connexions with his finger-nail, and then proceeds to pass the ligature ; in doing which Mr. Guthrie says that it is desirable if possible to see the vessel, and for this purpose directs that the lips of the wound be retracted. The artery, however, lies at so great a depth that it can only be brought into view if the person be spare. Great care accordingly is required to avoid wounding the peritonæum, the ureter, and the vein which accompanies the artery. The termination also of the inferior mesenteric vessels (superior hæmorrhoidal) may be injured in operating on the artery of the left side.

The cases in which this operation is required must be very rare. Of seven cases contained in the *American Journal of Medical Sciences* (vol. xiii.), three recovered, and four died. Mr. Syme's successful case is to be added to these; so that the operation has been sufficiently successful to encourage its repetition.

T. HOLMES.

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* *Commentaries*, p. 270.

AFFECTIONS OF THE MUSCULAR SYSTEM.

ALTHOUGH muscles are so much exposed to accidents and violence, they are not readily injured; nor, considering their high organisation, are they frequently the seat of disease. Muscles may suffer from contusions, strains, rupture, and wounds of different kinds. Severe contusions are frequently followed by temporary loss of power in the muscle; this, together with the extreme pain in any attempt to move the part, particularly in the neighbourhood of the large joints, sometimes leads to the suspicion of more serious injuries, as fracture or dislocation. Strains of muscles are often followed, especially in later life, by pains of a lasting and troublesome character, partaking of the nature of rheumatism. Muscle may be ruptured either from external violence or from the too energetic action of its own fibres; this latter occurrence is by no means a common one, especially that in which the entire muscle is torn across. In the living body, muscle offers a greater resistance to a force tending to rend it than either tendon or bone; and when it does give way, it is for the most part at its point of junction with the tendon. Sédillot* says, that in twenty-eight cases of rupture of muscles, thirteen were ruptured at this point. The power of resistance in a sound and healthy muscle in a state of full tonicity is enormous; and many interesting comparisons and calculations on this subject will be found in Borelli, *De Motu Animalium.* Percy† relates the case of a person with wry neck, who was suspended by the head, with a view of putting the muscle on the stretch; the result was separation of the muscle from its insertion, but no laceration of its fibres: and in a case in which the thumb was torn off, the tendons were drawn out, but the muscles were left uninjured, except at the point of junction with the tendon. We are all familiar with the fact, that the tendon of the rectus femoris and the tendo Achillis give way rather than the fibres of their respective muscles. With the loss of its vital contractile power, muscle loses its advantage over tendon, and the experiments of Richerand and others fully establish the fact, that after death muscle is more easily ruptured than tendon. We observe this when a limb is forcibly straightened from the bent position after the muscles have become unusually rigid from convulsions before death; here laceration of the muscles, and not of the tendons, takes place.

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* *Mém. sur la Rupture musculaire;* Mém. et Prix de la Soc. de Méd. de Paris, 1817, p. 155.

† *Journal général de Médecine,* vol. lxi.

Though muscle in the living body is not often ruptured, yet cases of rupture occur sufficiently often to have given most of us one or more opportunities of witnessing it. Sédillot has recorded no less than twenty-eight cases of entire or partial spontaneous rupture of muscles; but he observes, that no voluntary act can occasion a rupture of their fibres, however powerful the effort may be, and this for two reasons: 1st, because, under the influence of the will, all the fibres of a muscle, and the muscles associated with it in its action, contract uniformly, simultaneously, and in a regular order, to overcome a resistance; and 2dly, because at the moment that the will perceives that the power opposed to it is greater than its efforts can overcome, it ceases to strive further. Rupture, therefore, can only take place when, in some involuntary or instinctive effort, as in the endeavour to recover the equilibrium in a false step, or from some similar cause, the whole force is thrown in a violent and unexpected manner upon one or two muscles, or even on a few fibres. Among the cases collected by Sédillot, is one in which the rectus femoris was ruptured. In another case, the psoas magnus muscle was found ruptured after death, the patient having died from inflammation and suppuration following the accident. The complete rupture of the biceps muscles of each thigh occurred in a man falling from a height; and the two recti abdominis were ruptured at their upper part in a young man, in the struggle to save a tray of cement as he was falling from a platform.

It more frequently happens that a few fibres only of a muscle are ruptured, and this usually occurs in the gastrocnemius.* Muscles are sometimes torn across in violent paroxysms of muscular spasm, as in tetanus. In these cases the ends of the muscle, from the violence of the retraction, are thrown into considerable swellings. In a case of acute traumatic tetanus, under Larrey, the man was immersed in cold baths, after each of which the convulsions and muscular contractions were most severe, and he died in three hours; a swelling, however, had been previously observed below the umbilicus, on the right side. On a post-mortem examination, it was found that the tumour was occasioned by the retracted ends of the rectus, which was entirely torn across. The space between the two ends of the muscle was filled with blood. Mr. Curling describes a case in which portions of both recti abdominis were ruptured by tetanic convulsions (one of the specimens is in the museum of the College of Surgeons). Mr. Gray exhibited, at the Pathological Society, the rectus muscle of a patient who had died of tetanus, in whom almost complete transverse laceration of the muscle had taken place. In Mr. Earle's case of tetanus, described in *Med.-Chir. Trans.* vol. vi., one of the psoas muscles was partially ruptured. Boyer relates the case of a strong man admitted into La Charité with "bilious fever;" an emetic was given him, and whilst vomiting, acute pain was felt a little below the middle of the left rectus abdominis muscle. On examining the part, there was neither tumefaction nor discoloration of the skin, but an indentation, into which the fingers could be placed, was felt. The man died; and the muscle was found completely torn across, the two ends being an inch apart, and the space between filled with blood.

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* Wardrop, *Med.-Chir. Trans.* vol. vii.

The rupture of a muscle is accompanied by extreme pain, resembling that occasioned by a smart blow from a whip or stick, and often by a distinct sound like the snapping of a cord; all motion of the part is either impossible, or is accompanied by such severe pain, with spasmodic twitching, as to cause the patient to desist. If the muscle be a superficial one, a deep indentation will be found at the seat of rupture, produced by the retraction of its divided ends; and often a considerable swelling, proportioned to the vigour of the contraction of the torn fibres, as in tetanus; and as there is always extravasation of blood, much discoloration of the skin will follow. The indentation and extravasation are not apparent, however, in ruptures of the deep muscles, by which their diagnosis is rendered less clear. If the rupture be discovered early, and judiciously treated, a sufficient approximation of the divided ends will result, good union will follow, and the function of the muscle will be restored. If, on the other hand, it be overlooked or maltreated, or if it occur in a part where proper measures cannot be employed to approximate the ends of the muscle, as in some parts of the trunk, in ruptures of the deep muscles about the hip and shoulder, &c., it will be found that a wide separation exists, and that the ends of the muscle, instead of uniting, have become attached to the parts in the immediate neighbourhood, and the use of the muscle is consequently lost.

The treatment consists, 1st, in placing and retaining the part in a position most favourable for relaxing the muscles; and, 2d, in approximating the separated ends to one another by even compression, which we know exercises so great a power in controlling and modifying the excess of contraction in the muscles in fractures, &c. As regards the first, this is easily accomplished in the limbs: thus in rupture of the rectus femoris the knee is straightened, and the limb is raised to an angle with the body, as in fractured patella; but where the rupture occurs in the trunk, this cannot be done so readily; yet in the case above mentioned, in which both recti abdominis were ruptured, a good union was effected by keeping the patient in a sitting posture, the body being bowed forward, together with proper bandages.* The second is accomplished by an even and uniform compression of the muscles by means of carefully-applied flannel bandages, or laced belts, aided in some cases by a strip of leather or gutta-percha. At the end of from a fortnight to three weeks, the union is generally completed. The process of union is similar to that of other structures; the effused blood is absorbed, plastic lymph is poured out, which assumes by degrees the firm and resisting character of tendon, muscular fibre itself being never reproduced. When a muscle, with the integument and parts around, is divided, it retracts to a greater extent than where the muscle alone gives way, from being deprived of its collateral support. This, in conjunction with an open wound, renders it extremely difficult to approximate the retracted ends of the muscle, and to find means for retaining them in a proper position; hence it will be found that wounds extending through muscles are followed by nearly complete loss of their use, the great chasm between their ends being filled up by granulation. It is recommended to endeavour to bring the ends together by sutures. These, with a position favourable for the approximation of the ends, and such encircling supports as can be employed where a wound is present, may do much towards restoring the muscle to a certain amount of usefulness.

Inflammation of muscle. Independently of rheumatism, muscles may be the seat of inflammation from various causes, both simple and specific, which may terminate in abscess, or in some morbid changes of structure, to be described hereafter. Inflammation followed by abscess occurs occasionally in the parietal muscles of the abdomen, arising either from some injury or without apparent cause. It appears first as an extremely painful, and more or less circumscribed swelling, distinctly felt below a portion of the muscular planes: after a time obscure fluctuation is perceived; pain is now very great, especially on the least movement, accompanied by irritative fever. On laying open the abscess, pus, discoloured and somewhat offensive, escapes, the symptoms quickly subside, and the cavity readily fills up and heals.

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* Richerand, *Nosographie Chir.* vol. ii.

Purulent deposits in the pectoral muscles, extending to the intercostal muscles and diaphragm, occurred in a case described by Mr. Hacon in *Path. Trans.* vol. v. p. 329. The patient had rigors and other symptoms of fever ten days before his death, with great pain in the right hypochondriac region; formation of matter was suspected, and pus followed the introduction of a needle. There were no purulent deposits in any viscus.

Secondary deposit of pus sometimes takes place in muscles as well as in other structures. A case is given of phlebitic suppuration in muscle, originating in what he terms puerperal rheumatism, by M. Cruveilhier.*

Inflammation may occur in muscles as a symptom of secondary, or rather tertiary, syphilis. In a paper read before the Royal Medical and Chirurgical Society in January 1845,† I described a group of three cases, two of which were associated with other symptoms of constitutional syphilis, whilst the history of the third case was obscure. The disease, which I had not seen described before, appeared in the form of rounded enlargements in the left sterno-cleido-mastoid muscle; there were three swellings in two of the cases, and two only in the other; in one of these there was also an enlargement in the tendinous origin of the muscle; the tumours were evidently formed in the substance of the muscles, and were nearly of the size of a pigeon's egg, and gave a singular beaded appearance to the muscles; there was stiffness, with much tenderness, in the part, and great pain when the muscle was in action; the skin was neither adherent nor discoloured; the disease was slow in its progress, and had remained nearly stationary for some months. All the cases occurred in females, probably from the neck being more exposed than in men; in each case the effects of the iodide of potassium were manifest. In the first case the patient obstinately refused to take the iodide of potassium, in consequence of which mercury and various other remedies were tried without any good effect. After some time she consented to take the iodide of potassium; from two to three grains were administered thrice daily, and the iodine ointment was applied externally; the tumours soon began to diminish, and in less than six weeks completely disappeared. The other two cases were similarly treated, with complete success; but in one of them the patient was obliged to lay aside the remedy for a time, during which it was remarked that the tumours became stationary; on her resuming the medicine, however, all remains of the disease quickly left her. What constituted the swellings I was of course unable to ascertain from these cases; but a case occurred some time after, in which there was a tumour in the middle of the biceps muscle, so hard and defined as to induce the Surgeon to proceed to its removal by operation, when, on cutting into the fibres of the muscle, no tumour was visible, but the muscle in that part was congested and infiltrated with a grayish kind of lymph, great part of which oozed away with much blood, all the swelling subsided, and the wound healed, leaving no enlargement. Much light has been thrown upon the nature of these affections of the muscles and the changes they undergo by M. F. Bouisson of Montpelier, under the title of *Tumeurs Syphilitiques des Muscles.*[*] According to him, both tendons and muscles are the seats of syphilitic tumours and contractions, which occur in conjunction with other symptoms of constitutional syphilis. He has observed these tumours in the glutæus maximus, the vasti, trapezius, the sterno-cleido-mastoideus; also in the muscular structure of the tongue, lips, and pharynx. With regard to the treatment, he for the most part found the iodide of potassium, given internally, with the external use of the iodine ointment, very effectual in removing the tumours, except those of the tongue and pharynx, which were very obstinate; in these cases the muriate of gold, in doses of from $\frac{1}{16}$th to $\frac{1}{8}$th of a grain, was given with success. M. Bouisson was fortunate in having opportunities of seeing this disease in its advanced stages, as well as the stage above described. He found the enlargement continue with little change, except under the treatment of the iodide of potassium, &c., for a considerable period. Sections of the tumours presented an infiltration and deposit between the fibres of a gray plastic exudation; many of the muscular fibres were nearly colourless. This state may be followed either by a softening of the effused matter and its conversion into a kind of mucilaginous fluid, or may form an abscess, which, on slowly getting to a head, may burst, and leave an unhealthy ulcer with sloughy surface and foul discharge. Some of these enlargements, instead of suppurating, harden and become converted into cartilaginous or even bony structure.

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* *Path. du Corp Humain*, fasc. 17.

† *Lancet*, Feb. 1, 1845, p. 136.

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[*] *Gazette Médicale de Paris*, July 1856.

A case is described in the *Gazette des Hôpitaux*, January 16, 1858, of a tumour involving nearly the whole length of the sterno-cleido-mastoideus muscle. When the muscle was contracted, the swelling was immovable, but in the relaxed state it could be moved on the deep plane of fibres; the skin, though not adherent, did not slide readily over it as natural, and there was a slight blush on it; there were dull pains in the part, which occurred at uncertain intervals, not more by night than by day; neither respiration nor deglutition was impeded. There were decided traces of old constitutional syphilis, as in most of the cases reported. The patient was about to undergo a course of the iodide of potassium.

Sometimes these swellings assume the form still more completely of defined tumours. M. Robert* describes a case of a tumour which formed in the calf of the right leg as large as an egg, hard, unequal, and lobulated on the surface, somewhat movable, tender to the touch, but not painful, which was completely cured by the iodide of potassium. In *Path. Trans.* vol. vii. a very interesting account of a tumour is given by Mr. S. Jones; the tumour was removed by Mr. South from a patient in St. Thomas's Hospital, November 6, 1855. The patient had had syphilis eight years before, when he took mercury, but had no constitutional symptoms. He had received a blow on the left shoulder two years previously, and lost for some time the use of the arm; he, however, gradually recovered it after some months. He had pains in the shoulder, which were considered rheumatic, and were treated and cured by the iodide of potassium; nodes also presented themselves at several points, but they disappeared. Violent pains again came on in the shoulder, which were followed by a tumour in the infra-spinal region of the scapula; this increased rapidly in size; his general health suffered considerably. The tumour was well defined, moved only with the scapula, did not project much above the surface, and measured 6½ inches in one direction, and 8 in another; it was removed with a large portion of the scapula. On examining it, it was found to be formed in the muscles, but principally in the infraspinatus, though nodules were found in many of the neighbouring muscles. The tumour was mostly hard and dense, slightly elastic, of a dead white colour, and of a homogeneous or slightly reticulated structure; the surrounding muscular fibres were directly continuous with its surface, and muscular fibres were present in great abundance in many parts of the tumour. Many of the fibres, examined by the microscope, had lost their striated character, and had become glistening, transparent, and structureless. The spaces between the fibres were occupied almost solely by cells. Mr. South has since informed me that the wound healed well, and there has been no sign of returning disease.

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* *L'Union Médicale*, no. 37, mars 29, 1839.

Simple contraction, or shortening of a muscle without apparent alteration in its structure or change from its normal condition, seems to be an occasional effect of the inflammation from syphilitic poison in the system, and is usually found in the muscles of the arm or fore-arm. M. Ricord has noticed this so long ago as 1842.* M. Notta, in an interesting paper on Syphilitic Muscular Contractions,† gives three cases, the features of which were much the same; and in each the biceps was the seat of the contraction. There was no hardness or rigidity of the muscle when not in action; the pains were variable, being great on putting the muscle on the stretch, and mostly referred to its insertion. The contraction was slow, and gradually reached a certain point, causing fixed flexion of the elbow. The iodide of potassium, with minute doses of the proto-iodide, appears to have cured every case. The same may be said of the cases cited by Ricord‡ and others, in which there was a certain change of structure of the muscle, associated with contraction. As a general rule, mercury has done no good; in fact, in many of the cases the disease appeared to increase while the patient was undergoing a course of mercury.

Muscle is occasionally the seat of atrophy, with or without fatty and fibro-cellular degeneration.§ Fatty degeneration occurs both in the voluntary muscles and in the heart, the fibres of which bear a close affinity to those of the muscles of animal life, presenting the same striated appearance of their elementary fibres. Fatty transformation, as described by Dr. Quain, on Fatty Diseases of the Heart,‖ presents two distinct forms; viz. that in which the fat is situated on the surface of the organ and in the interstices of its fibres, and which he calls "fatty growth;" and that where it is found within the membranous tubes containing the muscular element which it ultimately supersedes, and which he terms "fatty degeneration:" the first has all the characters of adipose matter elsewhere; the other is composed of opaque granules of great minuteness, with here and there ordinary fat-globules of the usual kind. Fatty transformation occurs in the voluntary muscles, from various causes; it always in a greater or less degree accompanies atrophy of the muscles, whether from paralysis or from any other cause which, by interfering with the exercise of their function of contractility, deprives them of this their great source of health and nutrition, such as stiff joints, distortions, or other affections in which they are condemned to permanent inaction. Under these circumstances, fatty change is often accompanied by fibro-cellular degeneration, and the progress of atrophy is rapid; whilst that form of fatty disease I am about to describe (as far as my limited space will allow), and which tends to involve the entire muscular system, is of a protracted nature, and sooner or later terminates fatally, either from the encroachment of the disease upon muscles employed in vital offices, or from casual attacks of fever or of inflammation, mostly within the thorax. These attacks are, for the most part, slight in themselves, and do not at first create alarm; but owing to the low condition of the vital powers always associated with this disease, the patient sinks almost without an effort towards reaction. Let me begin the description of this disease by the following account of the appearances presented by dissection in a case described by Mr. C. J. Hallett,* under the head of Adipification of Muscle, or Steatosis. The case is that of a man aged 78, who died, it was said, of paralysis (but the brain had been removed from the body when it came under Mr. Hallett's notice). The form and development of the muscles were as usual, but the great majority of them were of so pale a colour as to be scarcely distinguishable from the surrounding tissues, and had undergone in most parts complete transformation into fat; some only partially so, and a few were altogether natural; fatty matter was also extensively present in the heart. The degeneration seemed constantly to have commenced on the surfaces of the muscles, and extended inwards to their centre; so that many which appeared wholly converted into fat exhibited in their interior muscular fibres in a more or less healthy condition. The first stage of the change consisted in the obliteration of the transverse lines on the fibres. The fatty matter in these cases appears to be deposited within the sarcolemma, sometimes beginning at one end of a fibre and extending towards the other, or beginning in the centre and extending to either extremity; it appeared in the form of minute opaque globules or corpuscules arranged in a linear form, with occasional ordinary fat-globules, which from their greater size filled the breadth of the tube, or even caused it to bulge. As the disease advances, the fat-globules increase at the expense of the opaque molecules. The sarcolemma gives way, and the fat-globules find their way into the cellular tissue between the fibres. The breaking up of the sarcolemma, and the escape of the globules, seems to have the effect of destroying all appearance of fibre, and nothing but a mass appears left like adipocire; yet even here the element of muscle or myoline is not totally lost.

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* *Gaz. des Hôpitaux*, p. 98.

† *Archives générales de Médecine*, ser. 4, vol. xxiv. p. 413.

‡ *Gaz. des Hôpitaux*, 1846, p. 1.

§ See Mr. Paget's Lectures, *Med. Gaz.*, 1847, pp. 143, 227.

‖ *Med.-Chir. Trans.* vol. xxxiii.

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* *Edin. Med. and Sur. Journ.*, April 1849.

In vol. xxxv. of *Med.-Chir. Trans.*, Dr. Meryon has given a very interesting account of a case of "granular and fatty degeneration of voluntary muscles;" and Mr. Leggatt has described a case of the same nature in vol. viii. of *Path. Trans.* In both papers much interesting matter is contained, and many cases and facts are referred to. The case described by Dr. Meryon is that of a young man, the eldest of four sons, who died at the age of seventeen, of the disease in question. He was a fine and healthy child when born, but always lay heavily in his nurse's arms; when he could walk, which was late, he walked without elasticity, and was unable to jump off the ground; this state of things continued until he was eight years old, when he walked more heavily, inclined to trip, and could not make an effort to recover himself. At the age of fourteen, when Dr. Meryon saw him, the upper extremities were failing; still the mass of the muscles did not appear to diminish, and he was well-grown. From this time to the period of his death, the loss of muscular power increased, the body and limbs became attenuated, the spine was curved forward, and the limbs were bent and stiff. He died in December 1850, of a low fever, with no prominent symptoms, except indisposition to take food, and difficulty in deglutition. I examined the body with Dr. Meryon. It was much wasted, the spine was curved, the chest flattened, and the limbs rigidly bent; the viscera were healthy, the heart entirely free from fat, but the voluntary muscles throughout were atrophied, soft, and colourless, as described in the former case. These and the microscopic appearances have been well described, with faithful delineations, by Dr. Meryon. Neither the brain nor spinal cord, nor the nerves proceeding from the latter, presented any abnormal appearance, though each underwent a most careful scrutiny, more especially the anterior columns, with their nerves. A few years later a second son died, aged sixteen, of a similar disease, which had run the same protracted course; the body was not examined. Since then a third son has fallen a victim to this disease, at the same age, although the immediate cause of his death was an attack of pneumonia, which his weakened frame was unequal to resist. The fourth and only surviving son, aged ten, is of a slighter form, and has hitherto shown less decided symptoms of the complaint, but they certainly exist. All the female children, six in number, are, on the whole, healthy; some of them having, however, shown a few strumous symptoms. Mr. Leggatt in his paper has described a case of a youth very similar to those above, but which was complicated with slight softening of the spinal chord, the roots of the nerves being healthy. The first symptoms of the disease showed themselves when he was about eight years old, and he died from an attack of pneumonia at eighteen. All these cases, and several others recorded or referred to by both Dr. Meryon and Mr. Leggatt, commenced at an early period of life, were extremely slow in their progress, and occurred only in male children,* and often in several in the same family; and on referring to the tabular sketch in Mr. Leggatt's paper, it will be seen that the nervous system was rarely altered from the healthy state. I must now shortly refer to the papers of M. Aran and M. Cruveilhier, in the *Archives générales de Médecine;* the former in 1850, the latter in May 1853 and January 1856. M. Aran records, under the name of *atrophie musculaire progressive*, eleven cases of fatty degeneration; they occurred chiefly in middle-aged persons, two of whom were females. In most of these cases a limited number of muscles only were affected, and in the only three fatal cases two belong to M. Cruveilhier's paper, and will be spoken of shortly; and the remaining case was not examined. The symptoms appear to have been similar to those above described, namely, wasting of the muscles, but not of the limb generally, giving a hollowed appearance in the courses of the muscles. Some cases seem to have arisen from long-continued use and fatigue of certain muscles, the first symptoms being feebleness, increased by fatigue and cold, with cramps and subsultus. M. Cruveilhier gives a detailed account of three well-marked cases which terminated fatally and were carefully examined after death: he calls the disease "*paralysie*" *musculaire atrophique progressive.* The patients were of the respective ages of eighteen, thirty-two, and forty; the last a female. The disease exhibited symptoms similar to those already described, and the post-mortem examinations, which appear to have been conducted with the greatest care, showed extensive fatty degeneration; and in two cases the muscular structure of the tongue had undergone almost complete fatty conversion. In all, the brain and spinal cord were found perfectly healthy; but in two, and more especially in one of them, the roots of the anterior spinal nerves had become atrophied. The hypoglossal nerves had also wasted in the two cases in which the tongue had undergone fatty degeneration. I will conclude this sketch by mentioning the case of complete fatty degeneration described by M. Virchow. The muscles were pretty generally affected with the disease. The posterior columns of the spinal cord had undergone great change, viz. disappearance of the nervous tubes, fibres only here and there, and distributed mostly in pairs, wide apart, with a granular structure, and here and there amylaceous bodies between them. The remainder of the cord, and both the anterior and posterior nerves were entirely free from disease.

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* Dr. Meryon has since informed me that he had become acquainted with two cases that occurred in two children, a brother and sister: the latter recovered, and was quite well; but the former died, after the usual protracted course.

Such is a sketch of this singular disease, the symptoms it presents, and the appearances which are found after death. Its causes are extremely obscure. M. Cruveilhier considers the disease as a species of muscular paralysis, the effect of atrophy of the motor nerves, by which the muscular fibres are deprived of the stimulus to contract so necessary to their nutrition. Nor is it surprising, looking at the results of the post-mortem examination of two of his cases, that he and those engaged with him in the inquiry should have taken this view of the disease; but further observations have shown that atrophy of the motor nerves is a rare accompaniment to the disease; and M. Aran and others consider the disease to be purely one of the muscles themselves, in which the nerves play no part, and arising from defective assimilation (see two interesting papers on the discussions which have arisen on this subject, in Nos. 14 and 16, *Gazette Médicale* for 1853, by M. J. Guerin). It is certain that in some the entire nervous system is perfectly normal, as in the case examined by Dr. Meryon and myself (this is omitted in Mr. Leggatt's table), and in that of the brother who died recently, and where a most careful post-mortem examination was conducted by Mr. Skey, Dr. Meryon, and others (at which I had the privilege of being present), where not the slightest lesion of any part of the nervous system could be detected. In some few instances the cord has been found softened; in M. Virchow's case the posterior columns being alone affected; and in all, the nerves were in a healthy state. However much, therefore, the degeneration of the muscles may have been influenced by the atrophy of the motor nerves in M. Cruveilhier's cases, it is clear that the nature and causes of this disease must be sought for elsewhere. It is well known that muscle after death, when exposed to moisture but excluded from air, becomes converted into adipocire, a substance of much the same nature as fatty degeneration in its complete state. Whatever weakens or lowers the standard of the vital powers in the animal economy, tends to bring its component parts under the influence of those laws which govern inorganic matter. Hence Dr. Quain (loc. cit.) considers that the process of fatty conversion is rather of a physical or chemical than a vital nature; that the debilitating effects of many diseases show themselves by fatty degeneration both in the tissues and in fibrinous and morbid deposit; and when it is remembered that struma in its usual forms had shown itself in members of the family of most of those who were affected with fatty degeneration, it might appear probable that to this deteriorating influence the muscular atrophy is due. It is true that we do not usually look in muscle for indications of this disease, but neither until comparatively lately was it supposed that the muscular structure was often the seat of syphilitic changes.

Treatment. Muscle that has undergone fatty degeneration can never be restored; it can no longer be said to be part of the living body; treatment must, therefore, be directed to arrest the progress, or prevent the invasion of the disease, and would be rather of a prophylactic than a curative nature. Hitherto medicines of all descriptions seem to have failed in making any impression on the disease, whether mineral or vegetable tonics, alteratives, baths, frictions, &c. (I do not know if the iodide of potassium has been continued for any lengthened period in these cases.) M. Rodet* gives a remarkable case of what he terms *atrophie musculaire progressive syphilitique* in a healthy man, æt. 56, in whom several of the muscles of the arm, fore-arm, and hand had become weak and wasted, and the limb had become almost entirely useless. This condition of the muscles followed indurated syphilitic sores that had resisted the mercurial treatment, as had all the subsequent secondary symptoms. Under a lengthened course of the iodide of potassium, the muscles completely recovered both their size and powers. How far this remedy would avail when the disease springs from other lowering causes, I cannot say—probably not at all; and we have yet to look for a remedy for this disease according to the condition giving rise to it. In the case of the fourth son recorded above, I understand that he has been living apart from his family, under the direction and care of a highly intelligent friend, who devotes much time and care to him; that he resides in a fine and bracing atmosphere; is kept in constant exercise of his muscles, with a highly nutritious diet; and that the disease has but slightly shown itself in him. M. Aran has found some benefit follow the use of localised electricity: possibly his cases may have partaken more of the nature of those resulting from defective nervous influence; for it has been shown by Dr. J. Reid's experiments,* that the irritability and healthy condition of muscles may be kept up by the stimulus of electricity as effectually as by that of the nervous centres through these nerves; and, as Mr. Paget fairly concludes, atrophy, the result of paralysis, may be averted, and the muscles sustained in a condition to resume their functions, should the nervous powers be restored.† I have not been able to learn if any benefit has been obtained from electricity in fatty disease of the muscles; but in Mr. Leggatt's case the patient derived any thing but benefit from it. Friction, manipulation, and passive motion were of service in some instances.

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* *L'Union Médicale*, no. xxvi. 1859, p. 403.

Ossification of muscle. The conversion of muscle into fat is truly a degeneration, as it is a change from a highly organised structure into an amorphous mass of adipocire. The same may be said of the so-called bony deposits in many soft parts, which are not true bone either in their structure or their chemical composition; while the ossific growth in muscle possesses all the qualities of true bone, and is merely the development of one organic structure within another, to which the term 'degeneration' would ill apply. Mr. Hawkins, in a clinical lecture to which I shall have again to refer, remarks that the ossific deposit in muscle is that of true bone with cancelli, compact shell, periosteum, and cartilage, displaying also under the microscope all the signs of true bone. Mr. Quekett has kindly shown me some beautiful microscopical preparations, which prove the true bony nature of these deposits. Ossific growths may take place over a large extent of the voluntary muscles, or may be limited to one or two points. In the museum of the College of Surgeons is the skeleton of a man in whom nearly all the muscles of the back had become ossified, large sheets and masses of bone occupying the places of the latissimus dorsi, spinalis, and rhomboid muscles, forming large bony sheets on the back and sides, while large stalactical growths of bone spring from the pelvis, ribs, and scapulæ. The following case is valuable from the circumstance of its progress having been watched from its commencement up to its present very advanced state.

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* *Phys. Anat. and Surg. Research.*

† *Surg. Path.* vol. i. p. 120.

In June 1859, G. Brown, æt. 38, presented himself at St. George's Hospital with extensive ossification of the muscles, together with several exostoses both on the spine and ribs. The greater part of the latissimus dorsi on either side, especially at the free edges, was ossified; large masses of bone filled up the hollows on either side of the vertebral spines from the sacrum to the occiput, soldering all the bones together into an inflexible column. The ribs were likewise immovable, partly from being ankylosed to the spine, and partly by the ossification of the muscles connecting them with the scapula and spine; so that respiration was entirely performed by the diaphragm. The trapezius, and, apparently, the deep muscles at the side of the neck, contained large deposits of bone; both scapulæ were immovably fixed to the ribs, principally by the ossification of the serratus magnus and rhomboid muscles. In front, both the great pectoral muscles, from their origins to their insertions, were almost entirely ossified, presenting ridges taking the course of the fibres, and forming large masses at the folds of the axilla. The sterno-hyoid and thyroid muscles were much ossified; and these, together with the recent appearance of a considerable swelling below the chin, had been accompanied with so much difficulty in deglutition as to alarm him; he therefore came to the hospital to see Mr. Hawkins, under whose care he had before been. The fullness in the upper part of the throat was not hard, but very tender; it yielded to a second application of a blister in a few weeks, so that the genio- and mylohyoid muscles could be distinctly felt almost entirely ossified. The man had been a patient under Mr. Hawkins in 1843, and in that and the three following years was several times in the hospital for lengthened periods, when I had frequent opportunities of observing the progress of the complaint. But I will here briefly avail myself of a clinical lecture given by Mr. Hawkins on this case about a year after its commencement.*

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* See *Med. Gaz.* vol. xxxiv. 1844, p. 273.

G. Brown, groom, æt. 22, was admitted into the hospital, June 18, 1843, with swellings in the dorsal and lumbar regions, apparently in the spinalis and rhomboid muscles; the former hard like bone, the latter not; commencing a week before, after much exposure to cold and wet, with severe pain in the parts and in the neck and shoulders, like rheumatism. Up to the end of July several other enlargements appeared, some hard, some soft, in the pectoral, latissimus dorsi, and other muscles. By the end of August all the swellings had disappeared, and he was discharged; but was again admitted at the end of October, the tumours having returned more numerous and prominent than before. He had continued his medicines under which they had disappeared, and had not caught any fresh cold. Several ossified enlargements were found in the sites of the old swellings, especially one extending from the spine of one of the dorsal vertebræ to the base of the scapula on the left side. As this bony growth was fast increasing, and impeding the motion of the shoulder, it was dissected out on November 23; it lay between the trapezius and rhomboid muscles, and was intimately connected with both; fibres of both being inserted into it. One end of this bone was smooth, from playing on the end of the scapula; the other was fixed to the spines of the sixth and seventh dorsal vertebræ; its length was three inches, contracted in the middle, and about an inch broad at its widest part; the whole mass resembles the two phalanges of the thumb. Several large vessels were divided, and secondary hæmorrhage followed the operation, which lowered the patient much; the wound healed very slowly. Thus month after month for four years fresh tumours formed in different muscles of the trunk and neck, being at first soft, growing rapidly, then becoming hard, and after a time either disappearing altogether under the remedies given, or leaving a bony deposit behind. The new bone thus formed extended slowly towards either extremity of the muscle, in ridges corresponding to its fibres. From this time he was lost sight of, until he appeared again in last June as above mentioned. During that long interval, he said that he had had no more swellings or pain, and that the bony growths had slowly increased, with corresponding stiffness of the trunk and shoulders.

The cause of osseous growth in muscles is not, I imagine, easily explained. A tendency to increased bony deposit is not very uncommon, and shows itself in exostosis and extension of bony growth into the tendons inserted into the bones; but in ossific growth in muscle it is a distinct formation, and in no way, at first, connected with exostosis. It is of inflammatory origin, as the pain and swelling, and also the effects of remedies, would indicate. Mr. Abernethy mentions a case* of a lad in whom either an exostosis or bony growth in a muscle invariably followed a blow on the part. Mr. Hawkins alludes to an account of eighteen cases of bony growths in muscles among the recruits in the Prussian service; these were said to have been the result of inflammation in the deltoid and pectoral muscles. Inflammation of muscle is rare, and excess of bony deposit in the system is not very common; but when they both occur in the same individual, the exudative lymph in the former would seem to be favourable for a nidus for ossific deposit. As regards the treatment, no local measures answered so well as blisters, under which, with the exhibition of colchicum internally, considerable diminution of the swellings and relief of the pain took place. The swellings completely disappeared after a course of the iodide of potassium, at first five, and then seven, grains thrice a day in sarsaparilla; but they returned again shortly after, while still taking the medicine. On the reappearance of the disease, mercury was given, two grains of calomel and a quarter of a grain of opium twice daily, which at the end of three weeks produced sore mouth; again, all the swellings were nearly removed, at first rapidly, then slowly; but a large mass of bone between the scapula and spine was removed, as stated, by operation. After this, from hæmorrhage and other causes, his health failed, and he was much reduced, and specifics were laid aside for some time. Numerous fresh tumours having, however, formed, he, in a few months, began the phosphoric acid, first in half-drachm, and afterwards in drachm doses three times daily, which he continued from April 6th to May 21st. The swellings greatly diminished under this treatment, and with the repeated application of blisters their recurrence seems to have been arrested. Thus the remedies appear to have been chosen with a view to the inflammatory nature of the complaint, and to have been most efficacious; yet so strong was the tendency to relapse, that the swellings formed again and again, even under the treatment that had caused them to disappear. They were, however, finally arrested, the blisters having been most conducive to that end.

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* *Surg. Lect.* vol. iii. p. 169.

Tumours in Muscles.

Tumours of different kinds are occasionally found in muscle. Perhaps that which occurs most frequently is the fibrous tumour, of a cartilaginous hardness, and often growing to a considerable size. A lad, aged 14, was under my care in St. George's Hospital in the summer of 1860, with a tumour as large as the double fist, at the back part of the left thigh, about its middle; it was extremely hard, and appeared to be a chondroid tumour growing from the bone, so closely did it seem to be attached to it; on relaxing the muscles, however, by bending the knee, it admitted of a certain movement on the femur. The tumour was removed, but not without difficulty, partly from its vicinity to the bone, which it seemed to grasp, and partly that the great sciatic nerve was imbedded in it, and was only freed by careful dissection. The tumour was found to have had its origin in the semimembranosus muscle, the lower part of which was healthy, but the part above the tumour was converted into a pale structure similar to the tumour, but less dense, and retaining the form of the muscle, with a slight remains of fibrous appearance. The tumour was extremely dense, of a semitransparent, cartilaginous aspect. Some of the fibres of the muscle were spread over the tumour; others dipped into it, but were soon lost in its substance.

Shortly after this, a tumour of a similar character was removed from the deltoid muscle of a young man by Mr. Johnson; it was about the size of an egg, and surrounded on all sides by muscular fibres. Many of the fibres entered, and could be traced a considerable way into the dense fibro-cartilaginous mass.*

The recurring fibroid, although it does not originate in muscular structure, has a great tendency to be reproduced in it. In two patients under the care of Mr. Hawkins in St. George's Hospital, each of whom had a tumour of this description in the breast, and in whom the tumours returned, and were removed several times, it was observed that when the recurrence took place the pectoralis major was the part principally involved. A man came under my care about two years ago, from whom a tumour of the above nature had been removed from the parotid region, and subsequently a recurring small one from over the masseter muscle; four months after which he became my patient, having a tumour about the size of a French walnut in the neighbourhood of the second cicatrix. On removing it, I found that it had formed in the upper part of the masseter muscle, a few fibres of which only remained. A few months after this, he again came under my care, with two tumours the size of filberts a little above the site of the last, and which proved, on dissecting them out, to have had their seat in the temporal muscle. I have at present a lady under my care from whose breast I have twice removed a tumour of the above nature; the disease has now returned in the pectoral muscle, in which it is making rapid progress.

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* Mr. Curling gives an account of a fibrous tumour which he removed from the gastrocnemius muscle of a girl, æt. 9; its circumference was not very clearly defined from the muscle, so that its more prominent central part only was removed. See *Path. Trans.* vol. vi. p. 346. Mr. Birkett removed a tumour from the short head of the biceps flexor cruris, of a chondro-ostoid growth, 4½ by 3 inches in size, of a grayish-pearl tint, and of cartilaginous structure; the centre was of bone. Ibid. vol. ix. p. 397.

Cysts of various kinds are occasionally found in muscle. A short time ago I removed a cyst from the biceps flexor cubiti of a young woman, aged 20. The tumour, which was unusually tender and extremely hard, was distinctly felt in the substance of the muscle, movable when the muscle was relaxed, but fixed and unmovable when contracted; it was of a globular form, and about the size of a walnut. Having cut down on the muscle, the fibres were separated, and the tumour was exposed. From its pearly appearance it looked very like a fibrous tumour, but on being punctured, turned out to be a cyst containing a semitransparent gelatinous substance, and at one point a small quantity of pus (this would explain its great tenderness). On proceeding to dissect out the cyst, I found that, though thick and defined, it was so blended on its outer surface with the muscle, that to do so would involve great destruction of the muscle itself. I therefore merely cut out the anterior face of the cyst, which was pretty free from muscular connexion, and having scraped out the contents, I dressed it to the bottom with lint, after which it readily filled up and healed. Some of these cysts contain hydatids. The trichina spiralis is described by Mr. Owen as an entozoon which infests the voluntary muscles. In the two cases in which these entozoa occurred, the persons had died after long and wasting disease; they were contained in minute cysts, sometimes singly and sometimes in pairs; the cysts were found dispersed in great numbers throughout the entire voluntary muscles; they were of an elliptical figure, $\frac{1}{50}$th of an inch by $\frac{1}{100}$th in diameter. Cysts containing a black tenacious matter are occasionally found in muscles; they probably are of the nature of hæmatoma occurring in other parts of the body, being merely unabsorbed extravasated blood, which has become darkened and nspissated by time. Warren describes a singular tumour of some-hing of this nature. A tumour about the size of an egg was removed from the substance of the rectus femoris muscle of a woman; t was said to be of only five or six months' growth; it consisted of , hard dark-coloured muscular substance, in the centre of which was a bony shell an inch in diameter, containing a dark-coloured luid, which had deposited a black crust on the bony cysts.

Scirrhus seldom originates in muscle, except in the tongue and ubstance of the lip. Warren describes a case of what he terms cirrhus of the muscle, which resembles more the account given of he syphilitic tumour described as having been removed from the houlder by Mr. South. Muscles readily become implicated in the isease occurring in neighbouring parts, and it is not unusual to ind the muscles for a considerable distance around a scirrhous reast dotted with scirrhous tubercles. Melanosis must be very are in muscles. Warren mentions a case occurring in the muscular structure between the base of the scapula and the spine; this had been removed, but a second tumour appeared in its place under he cicatrix; it was found, on operating on it, to be seated in the ubstance of the rhomboid and trapezius muscles; it was hard in tructure, and the interior composed of black matter; six months fter this, the disease reappeared, of a carcinomatous appearance, nd proved fatal.

Encephaloid tumours no doubt originate in muscles, though hey grow so rapidly, and involve every structure so indiscriminately, as makes it difficult, except in certain organs, to define their origin. Warren, speaking of this disease in muscles, describes three cases. These, however, are not clearly proved to have sprung from muscle, except the last, which had its seat in the lumbar muscles.

AFFECTIONS OF TENDONS.

Injuries of tendons. It has been already observed that tendons re ruptured by the action of their muscles more readily than he muscles themselves; they may also be ruptured by direct orce, as in dislocation, and they are often divided partially or ntirely in wounds and by subcutaneous sections. When a ten-on is ruptured, or, what is nearly the same thing, divided by ubcutaneous operation, the part which is attached to the muscle is rawn away from the opposite end for about an inch; this latter s but slightly retracted by the action of its antagonists. Blood is poured out between the ends, but much less than in rupture of muscles. The pain is said to be not very great; a considerable shock, however, is felt, as from a blow received on the part, accompanied by cramp of the muscle, and a perfect inability to use the limb; and in rupture of the tendo Achillis a feeling is described as if the heel were sinking into a hole in the floor. The tendons most frequently ruptured are the tendo Achillis, and the tendons of the rectus femoris and the triceps humeri. If the separation of the ends be not too great either in rupture or subcutaneous division, they unite with much readiness, the new material soon acquiring great firmness; so rapidly is the process of repair carried on, especially in the early stage, that, according to Mr. Paget, in his sixth lecture at the College of Surgeons, a specimen six days after division (being the fourth occupied in the organism of the new structure) could bear the weight of twenty-five pounds; in another case the new material at the end of twenty-one days bore a weight of fifty-six pounds. The process of repair is briefly this, according to Mr. Paget (loc. cit.). For the first forty-eight hours inflammatory matter is poured out, and infiltrates the tissues between the ends; after this there ensues infiltration of a material of the character of the fibrin of the blood in a solid state, in which are enclosed the unabsorbed remains of the clot of extravasated blood, and the two ends of the divided tendon; this by degrees assumes a definite cord-like form; but even in five or six days it shows a nucleated structure, tending to the production of tendinous tissue. On the tenth day, the material becomes paler and less vascular, and assumes a distinctly filamentary form; and in about three weeks there is a perfect cord, of the nature of tendon. Mr. Paget further remarks, that in the progress of the process the ends of the tendon swell and soften to the consistence of the effused matter, so that they merge one into the other, assuming thereby a closer adhesion. He also remarks that the repair of the tendon does not depend on the non-division of its sheath, as has been supposed. Should the interval between the two ends of a divided tendon be great, a very imperfect bond of union will be established between them, as the end will become attached to the neighbouring tissues, and either a partial or entire loss of the use of the muscle will result. Where the integuments and surrounding parts are included in a division of a tendon, there is, as in muscle, a much greater retraction than where these parts remain entire; added to which, the material for the repair of the tendon being here common to all the other tissues included in the wound, they all become fused in a common cicatrix, so that under the most favourable circumstances a very imperfect union and limited use of the muscle ensue.

The treatment of ruptured tendon consists, as in rupture of muscle, in approximating the divided ends, and retaining them in that position until firm union is established. Close adaptation cannot be hoped for, but still a perfect union with recovery of the action of the muscle usually takes place. The severed ends are brought closer and closer towards one another by the contraction of the new material as it becomes perfected, and the remaining deficiency is fully compensated for by the accommodating nature of the muscle. If the tendon of the triceps be torn, all that is required is a bandage from above downward, with a splint in front of the arm to keep it extended; and as the union of tendon is rapid, passive motion may be employed early. In rupture of the tendon of the quadriceps extensor cruris, the same treatment nearly may be adopted as for a fractured patella. Where the tendo Achillis is torn across, the treatment consists in keeping the foot extended on the leg, and the leg bent on the thigh; a position favourable to the relaxation of the gastrocnemii muscles. For this purpose a belt is placed round the thigh a little above the knee, the back of which is attached to the heel of a slipper by means of a belt or bar. Before applying the instrument, the calf of the leg should be bandaged from above downward, care being taken not to approach too near the seat of rupture, for a great displacement and permanent defect would result from the ends of the tendon being pressed towards the bones of the leg; somewhat of a similar inconvenience may occur from a too considerable or a too long-continued tilting up the heel. Desault, to avoid the displacement of the tendon by his bandage, which, like Petit's, extended over the whole limb, recommends compresses at the sides of the tendon. John Hunter, who himself had a rupture of the tendo Achillis, recommends that, as so little inconvenience attends a small separation of the tendon, compared to the great inconvenience and difficulties attending the treatment by bandages and straps, the parts should be allowed to remain in their natural position. He is, however, disposed to adopt a medium between the two, and suggests that the heel should be elevated during walking, by raising the heel of the shoe, that a bandage should be kept steadily applied to the calf of the leg, to guard against involuntary actions of the muscles; and that at night the usual slipper and strap might be applied. When the integuments and surrounding parts are included in the division of a tendon, the edges of the wound may be brought together by adhesive plaster, or perhaps by sutures. The mode of bringing the divided ends of the tendon together by means of sutures can scarcely be recommended, as they produce irritation, and keep the wound open. Bandages are not well borne; rest, therefore, with position, must mostly be trusted to for the cure.

Inflammation of tendons. Tendons, together with their sheaths, both fibrous and synovial, are not unfrequently inflamed. Independently of gout and rheumatism, the most frequent cause is a sprain or wrench in the neighbourhood of a joint. These injuries are occasionally productive of long-continued wearing pains, assuming much of a rheumatic character, and yield often slowly and unwillingly to the remedies, both local and general, employed in rheumatism. Sometimes these sprains are followed by inflammation, with great effusion into the sheath and surrounding cellular tissue (especially in the region of the foot and ankle), which, either rapidly in an acute form, or slowly in a chronic form, may extend to the ligaments and periosteum, destroying the joints, and producing caries of the bone.

Under the name of "ténosynite crépitante," the French describe a slight degree of inflammation of the sheaths and investments of the muscles and tendons: it follows long-continued and fatiguing muscular exertion, and for the most part occurs in the muscles of the fore-arm. I have observed it mostly in the extensor muscles of the thumb as they pass over the radius; it is usually accompanied by considerable pains extending up and down the limb, and a well-marked crepitating or creaking feeling can be felt by grasping the part while the muscles are in action. The treatment consists in complete rest, and stimulating or even vesicating applications. In one of the forms of whitlow, *paronychia tendinosa* of Abernethy,* the tendons and their sheaths in the finger and hand are the seat of a severe and often most destructive inflammation, which, though often confined to one finger, not unfrequently extends to the hand and arm, attacking not only the tendons and softer parts, but exposing the bones and disorganising the joints. It arises from the same causes as the other forms of paronychia, slight wounds, pricks, with or without inoculation of irritating or poisonous matter, and often without any evident cause, though doubtless depending much on the state of the general health. It begins with severe and throbbing pain on the palmar face of a finger, which extends along the arm, often to the shoulder; it is accompanied by redness and swelling, with great hardness and tension: if not checked, the inflammation proceeds quickly along the front of the finger, and is soon followed by suppuration in the sheath; this at first is in small quantity, and, in consequence of the great hardness and swelling of the part, cannot be detected by the touch; if no relief be afforded, the suppuration quickly proceeds along the sheath, the inflammation and pain are aggravated by the density and unyielding nature of the parts, and are accompanied by much constitutional disturbance; abscesses burst externally from time to time as the disease extends along the sheath, from which fungous granulations spring, the tendon in a sloughy state lying at the bottom. With proper treatment, and in a favourable state of the general health, the progress may be arrested with a greater or less amount of destruction of the parts attacked, and a proportionate deformity. In certain unhealthy states of the system, however, in which the diffuse or erysipelatous form of inflammation prevails, the inflammation and suppuration extend into the palm of the hand, behind the palmar fascia, and to the rest of the fingers. The whole hand now presents a highly inflamed appearance, of an erysipelatous nature, with great swelling and tension; nor does the mischief end here, but, passing under the transverse ligament of the wrist, ascends into the fore-arm, forming large diffuse abscesses amongst its tendons and muscles; and in the worst cases not only the joints of the finger, but those of the carpus and wrist are destroyed, and the bones denuded and necrosed. The health during this time suffers severely from irritative fever, with gradual prostration of the bodily powers.

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* Lect. 28, *Lancet*, April 29, 1825.

Treatment. In the very early stage the inflammation may often be arrested by leeches, followed by hot fomentations to soften and relax the hard and unyielding tissues. The hand should be elevated, and an active purgative, with other antiphlogistic measures, prescribed; if relief do not soon follow, but, on the contrary, the continuance of pain and throbbing with increased hardness indicate the extension of the inflammation, if not the formation of pus, no further time must be lost; a free incision must be made along the centre of the finger, and though there may be but very little or no pus in the sheath, yet the division of the tensely strangulated structure, and the escape of blood and serum, afford the greatest relief. By these means all mischief may be arrested, and the finger perfectly restored. On the other hand, the inflammation may proceed along the sheath in spite of the most ready treatment; suppuration may have extended under the palmar fascia: further incisions must then be made; and it will now be found proper to support the powers of the system by a generous diet, stimuli, and tonics. In these cases the tendon will slough, and one or more of the joints will be ankylosed, with such disfiguration as may at a future time require amputation; for a stiff and distorted finger, in almost any condition of life, is very inconvenient as well as unsightly. In the more chronic states, where, notwithstanding free openings having been made in the palm, abscesses burrow about the hand, I have found the best results from pressure with pads of lint soaked in pure liquor plumbi, and a bandage, the powers being supported with tonics, good diet, and stimuli. Where the suppuration extends to the arm, the case is more serious; and if, from the state of the constitution before alluded to, it proceeds to the indiscriminate destruction of the joints, nothing but amputation remains, and even that may not save life. I have amputated the fore-arm twice for this disease: the first case was in a gardener, a patient at St. George's Hospital; he seemed healthy and strong, but the diffuse suppuration extended rapidly along the sheaths to the hand and arm, destroying the joints of the hand and wrist in spite of every endeavour to arrest the disease; and though amputation was performed before the powers were very much prostrated, it was only by constant attention and active treatment that after a long time the man recovered. The other case was that of a gentleman, æt. fifty-five, whom I attended with the late Mr. B. Cooper and Mr. H. Phillips: he was of a bad habit of body, pale and flabby, with a weak pulse; the suppuration, beginning in the little finger, spread with surprising rapidity along the sheath, quickly involved the other fingers, then the hand and fore-arm, destroying the joints in its course, in spite of free incisions and whatever could be devised in the way of support. Nothing produced the slightest check to the progress of the inflammation, nor any reaction of the system; it was therefore agreed that the arm should be amputated. I performed the operation unusually high up in the fore-arm, with a view to cut through sound parts; but even at this height the knife passed through the extremity of an abscess. No reaction took place after the operation; the stump soon assumed a flabby, half-sloughy state; and after some days the patient sank.

I have already remarked that tendons, as well as muscles, are the seat of syphilitic enlargements. In one of the cases recorded by me, the tendinous origin of the sterno-cleido-mastoideus was much thickened. M. Bouisson (loc. cit.), describing these swellings, remarks that they are formed by deposit between the fibres, as in muscles. He also relates a case of strabismus from a syphilitic tumour occurring in the tendon of one of the muscles of the eye. M. Lisfranc* speaks of certain node-like swellings on the surfaces of tendons, which he calls "nodosités blanches des tendons." Syphilitic enlargements of tendons do not, as in muscles, readily yield to the internal use of the iodide of potassium; they require an active local treatment as well, such as iodide and mercurial ointment, or blisters kept open with mercurial ointment. Swellings of the tendo Achillis occasionally occur without a syphilitic origin. I have found them in persons who have taken long and fatiguing walks, not having been accustomed to much exertion. These swellings sometimes occur as a simple rounded enlargement in the tendon, and sometimes as an irregular thickening; they are tender when handled, and are sufficiently painful in walking to make the patient limp. These tumours are often troublesome to cure, as they do not readily get well without rest, and the pain and inconvenience are not usually sufficient to induce the patient to lie up; in order, however, to cure them, it will generally be found necessary for the patient to lie up, or at all events to avoid using the part, and to apply the local means recommended in syphilitic tumours, as blisters kept open with mercurial ointment, or the emplastrum ammoniaci cum hydrargyro, &c.

Tumours of tendons. Malignant tumours do not often spring from tendon; it offers, on the contrary, like other fibrous structures, a lengthened resistance to their progress. Warren gives the following account of a malignant tumour growing in the substance of tendon. A round and prominent tumour appeared above the patella three inches in extent, without much pain or sensibility, but causing lameness; it had been growing six months. On cutting down, the fibres of the rectus tendon, which were stretched over the tumour, were separated, exposing a white fungous growth firmer than the ordinary fungous tumour, but breaking in pieces when handled. On removal, it was found to be mixed up with fasciculi of tendinous fibres. It showed no disposition to bleed. This tumour returned after the healing of the wound, and was again removed, when it presented a more decidedly fungoid character with fewer tendinous fibres. The case terminated fatally, with the formation of tumours within the abdomen. Fibrous tumours occasionally arise in tendinous structure, as in fasciæ, and other parts of a fibrous nature. Small cartilaginous enlargements are often found in the course of tendons, especially those of the hand and foot; they do not grow to a large size, and seldom produce any inconvenience. Small growths, described as tæniophytes by Albers de Bonn,* are sometimes found growing on the surface of tendons near their junction with their muscles; they vary in size from a pin's head to a cherry; they are at first altogether cartilaginous, but as they increase in size calcareous matter is deposited in them, as in the development of bone.

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* *Gazette des Hôpitaux*, no. 1842.

AFFECTIONS OF BURSÆ MUCOSÆ.

The closed synovial bags called bursæ mucosæ are of two kinds; those situated in the subcutaneous cellular tissue, and those connected with tendons. The subcutaneous bursa is formed of cellular membrane that has been exposed to friction and pressure, by which its cells are obliterated and a single cavity formed; it retains, in part, the form of its cellular origin, for even after great distention the interior often presents a sacculated or multilocular appearance. Like cellular membrane, it has much of the character of serous membrane, in its ordinary state exhaling a fluid little denser than serum, but assuming, after a time, much of the nature of synovia. The subcutaneous bursæ are numerous,† and are either normal or adventitious. The normal occur mostly between the skin and some bony prominence. The adventitious bursæ are formed below corns, bunions, or other accidental callosities, as those arising in talipes on the sides or back of the feet. These sacs are liable to become enlarged from various causes, mostly local, as pressure, friction, or blows, though occasionally constitutional. The bursa in front of the patella is most frequently the seat of enlargement, forming a tumour familiarly known as *the housemaid's knee.* The contents of these enlarged cysts vary much; at first they are distended with a fluid little more dense than serum, gradually acquiring more and more the nature of synovia; it is often mixed with blood, either recent or in a thick grumous state; sometimes there is a dark-brownish adhesive fluid containing cholesterine; occasionally, after long-continued pressure, fibrinous matter is deposited within the sac, something after the manner of an aneurism, which gradually fills up the cavity, forming a tumour of a dense fibrous structure;

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* Vidal, *Pathol. extern.* vol. ii. p. 763.

† Ibid. vol. i. p. 595.

sometimes it is solid throughout; more frequently there is a central cavity containing a gelatinous fluid; sometimes the fluid in an enlarged bursa contains numerous bodies, resembling melon-seeds or parboiled rice; these are of a dense, fibrinous nature, and appear to be either the result of broken-up deposit, the portions becoming round and smooth by motion and attrition, or productions from the inner surface of the fibrous deposit, which from the effects of motion and friction become first pedunculated, and then being detached fall loose into the fluid of the sac, much in the same way as occurs in the formation of loose cartilages in joints. Inflammation, terminating often in suppuration, sometimes takes place in bursæ mucosæ; we see it occurring in a previously healthy state of the part, after a severe blow or a wound, especially in the bursa over the olecranon; the inflammation runs very high, and is not confined to the sac itself, but, in a diffuse form, extends often over the whole arm, with much swelling, redness, and tension; the pain is great and the constitutional disturbance considerable, and in old people there is sometimes much danger. Pus forms rapidly, not only in the sac but also in the cellular membrane, if not relieved. Enlarged bursæ of the patella are frequently attacked by inflammation and suppuration, and usually there is extensive inflammation of the surrounding cellular structure; and sometimes such large collections of pus are found in the neighbourhood of the sac, as led Sir B. Brodie to consider that the suppurating bursa occasionally gave way, and allowed its contents to escape into the cellular membrane. The readiness with which the neighbouring cellular membrane is involved in the inflammation of subcutaneous bursæ, is probably due as much to the sameness of their nature as to the continuity of their tissue. Troublesome and burrowing ulcers sometimes remain after these abscesses, and sometimes from undue pressure and neglect of a hardened cyst. These ulcerations are singularly obstinate, sometimes with considerable fungous growths, the skin around being dark and unhealthy, with deep burrowings under the integuments about the knee, and a foul and offensive discharge.

Treatment. Whatever treatment may be adopted, it should be accompanied by complete rest. When the bursa over the patella is affected, a well-fitting ham-splint may be applied, and all motions of the knee-joint prevented. Simple enlargement, if recent, will often subside under rest and a slightly stimulating lotion, such as ammoniæ hydrochlorat. ʒj., aquæ ℥v., aceti ℥j. M. Some merely transfix the bursa with a needle, and leave it to itself. If the enlargement has been of some duration, with thickening, more decided measures will be required. Some Surgeons evacuate the contents by puncture, and follow it by pressure with a pad and strapping; the sac is likely, however, to fill again, and will require repeated punctures. Counter-irritants often effect a cure, such as the emplastrum ammoniaci cum hydrargyro, or a blister over the part. The iodine ointment or the tincture of iodine applied to the skin over the tumour, may in some cases succeed, especially where the contents have been previously evacuated. Mr. Key* recommends a seton, composed of a few threads of silk, to be passed through the cyst; suppuration is thus set up, and the pus escapes by the moving the threads from time to time; compression is also employed by mean of a pad and adhesive plaster, the openings being left free. By these means the discharge gradually diminishes, and, partly by contraction and partly by granulation, the cavity becomes obliterated. The French Surgeons often treat these cases with iodin injections, like hydrocele. When there is much solid deposit in the sac, Mr. Key still finds the treatment by seton the most effectual; for, considering that the induration is kept up by the irritation of the cavity, the seton, by producing inflammation and suppuration, would cause its obliteration, and the absorbents would remove the indurated walls. When the tumour has become almost o quite a solid, gristly mass, there is no remedy but dissecting it out which can readily be done; and I have never seen any bad consequences follow. Where the tumour is very large and overlaps the patella, care should be taken not to wound the aponeurotic covering of the joint.

In acute inflammation of the bursæ, both local and genera antiphlogistic measures are required; but where there is diffuse inflammation around, of an erysipelatous tendency, much benefit i derived from the sesquichloride of iron lotion,† with general support. If suppuration has taken place in the sac, it may either b laid open with a free incision, or a seton may be passed throug it; the former would be preferable where there is much surrounding inflammation, as it not only gives free exit to the matte but diminishes tension, relieves the vessels of blood and the cellula membrane of the effused serum, and often prevents it from running into suppuration. If pus have already formed in the cellula tissue, it will probably be necessary to make one or more incision for its escape, in as depending a position as possible, and the system will require general support and stimuli.

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* *Guy's Hosp. Rep.* vol. i. p. 415.

† Tinct. ferri sesquichlor. ʒj., aquæ destillat. ℥viij.

Of the adventitious bursæ, that of the bunion is the most serious. One of the effects of tight and ill-fitting shoes is the displacement of the toes from their natural directions; the great toe, more especially, is displaced in a direction outwards, forming an obtuse angle with its metatarsal bone, and rests either on or below the second toe, usually the latter. In consequence of this deformity a considerable strain is thrown upon the internal lateral ligament of the joint, under which it gradually yields; a kind of semiluxation takes place, and a considerable prominence is formed by the projecting base of the first phalanx. Upon this prominence a broad surface of horny cuticle is formed by pressure, and between the skin and the ligament a bursa is formed. Mr. Key,* in describing a bunion, says that the protruding phalanx sets up irritation in the ligament; this, in conjunction with pressure, produces a series of small cavities or cysts between the layers of the ligament; these cysts come forward in succession, and, becoming obliterated by inflammation, have the effect of warding off the consequences of pressure. From repeated pressure and irritation, inflammation from time to time takes place in the bursa, or cyst, accompanied by great pain and redness, with a sense of heat and dragging of the part; and though by rest and treatment these attacks readily subside, yet the repetition of irritating causes occasions a permanent tumour, which usually contains only the ordinary thin bursal fluid, but occasionally, as has been observed by Sir B. Brodie† and M. Boyer,‡ is filled with a dense crystalline secretion. Sometimes, from a blow or unusual pressure and irritation, suppuration takes place in the cyst; the abscess thus formed is slow in its progress, extremely painful, and usually opens after a time in the centre of the horny callosity by a circular aperture; after which the parts become quiet, and remain so until renewed causes set up fresh abscesses. By this time the ligament is destroyed by ulceration, the joint is opened, and a probe introduced discovers the cartilages eroded or altogether gone, and the bones exposed and carious. Sometimes, in neglected cases, abscesses burrow round and about the joint, the bones become necrosed, and the neighbouring parts greatly thickened and swelled, with so much pain as completely to prevent all locomotion.

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* *Guy's Hosp. Rep.* vol. i. p. 415, 1836.

† *Lect. on Path. and Surg.* 1846, p. 227. ‡ *Traité des Mal. Chir.* vol. xi.

Treatment. In mere painful enlargement, Sir B. Brodie recommends a large shoe to be worn, and a compress of three or more layers of amadou, spread with soap-plaster, large enough to cover some extent of surface, and cut into a horseshoe form. The bunion occupying the empty space, the horseshoe form of the compress prevents that bulging of the enclosed part which takes place in a circular opening. Where the bursa is large and painful, both Sir B. Brodie and M. Boyer recommend the cyst to be destroyed. This may be done, first, by opening it either by incision or caustic, and applying nitrate of silver or nitric acid · to the inner surface; care must be taken to ascertain that the cyst does not communicate with the joint, in which case the latter proceedings would be highly objectionable; and under any circumstances the nitric acid should be used sparingly and with caution. After one or more applications, the surface granulates and the cavity closes. In inflammation of a bunion it may be proper in some cases to apply leeches, with fomentation and poultice; where there is considerable surrounding inflammation, with much pain and dragging, the following lotion is often very useful: liq. plumbi diacet., tinct. opii, āā ʒj., mist. camphor. ℥ij. M. ft. lotio. When abscess has formed, it may be poulticed and opened. Mr. Key, however, preferred leaving the abscess to burst of itself, as being less likely to set up mischief in the joint. Under all circumstances, great benefit will arise from restoring as much as possible the toe to its natural direction: this may be done while the patient is lying up, by keeping a pad between the first and second toes; but when the patient is about, both the shoe and stocking should be made in such a way that there would be a separate compartment for the great toe: thus the strain upon the lateral ligament is removed or diminished, and a principal source of mischief taken away. Where, from long neglect or other causes, extensive disorganisation of the joint and parts around has taken place, amputation of the toe, with a portion of the metatarsal bone, appears the only resource. I have done this in a few cases, with the best results; nor has the loss of the toe proved such an impediment to the natural gait as might be expected. Very bad cases of this description, however, may be restored by long rest, fixing the joint with caoutchouc or some other splint, much attention, and good diet.

The bursæ of tendons have more the character of synovial membranes than the subcutaneous bursæ, and are either simple bags containing a lubricating fluid, placed between tendons and prominences of bones, as that between the ligamentum patellæ and the tubercle of the tibia, or complicated with numerous processes and elongations, as in the synovial sheaths of the flexor tendons of the hand and wrist. These, like the subcutaneous bursæ, are liable to enlargement, and often attain a considerable size; but, from their deeper situations, they are less exposed to injuries from without, and consequently do not so frequently inflame and suppurate. The bursa between the ligamentum patellæ and tibia sometimes enlarges and forms a tumour, which, by filling up the depression on each side of the ligament, presents the appearance at first of synovitis of the knee-joint; but the absence of swelling above and around the patella renders the diagnosis easy. Distention of the bursa above the knee usually accompanies synovitis, because this bursa almost always communicates with the joint; this, however, is not always the case, and I have at this time a patient with a large bursal tumour under the vasti, the joint being quite healthy. One of the bursæ of the hamstring muscles (usually that of the biceps) occasionally enlarges, and appears in the ham as a pulsating tumour, often of considerable size; it is, however, too little like an aneurism to be mistaken for one by a careful observer. The same may be said of the bursa of the subscapularis, and other bursæ about the shoulder-joint, which sometimes form tumours in the axilla, occasionally pulsating from their vicinity to the artery. The bursa between the psoas and iliacus internus and the capsule of the hip-joint sometimes forms a tumour, which from its situation may be mistaken either for an inguinal aneurism or for a psoas abscess; the extrinsic character of the pulsation and the absence of all other aneurismal symptoms in the one case, and the want of spinal symptoms and of fluctuation above Poupart's ligament in the other, assist in forming a right diagnosis. This bursa occasionally communicates with the synovial membrane of the joint, and when inflammation occurs in the former, the latter will most likely be involved in it, and serious mischief may follow. The bursa between the glutæus maximus and tuber ischii, that between the tendon of the glutæus medius and the trochanter, and that between the latissimus dorsi and the angle of the scapula, from their exposure to pressure and other sources of irritation and inflammation, are not only liable to inflame, but even to suppurate. When, from frequently recurring pressure in sitting, the already enlarged ischio-gluteal bursa inflames and suppurates, it increases in size, becomes painful, and renders sitting on the part impossible, and even motion distressing; lying deep under the mass of muscle, its fluctuation is obscure, and the suppuration is usually slow in coming to the surface, and after it is evacuated, it often leaves a sinus obstinate and slow to heal, from its depth and the movements of the muscle. The same may be said in most respects of the bursa over the trochanter. The bursa at the angle of the scapula often acquires a great size, and when it suppurates, much constitutional disturbance is often set up. Too much caution cannot be taken in opening these bursæ, whether in their simply enlarged state or in the suppurating stage, as an alarming and even fatal train of symptoms sometimes follows the operation.*

The palmar bursal tumour is perhaps the most obstinate of any; forming a swelling under the palmar fascia, it extends under the transverse ligament and ascends into the fore-arm, presenting a double tumour, the contracted part corresponding with the transverse ligament. The fingers are more or less drawn into the palm of the hand, and cannot be straightened. The fluctuation is readily felt by alternate pressure above and below, and when, which is often the case, the melon-seed bodies are present, a peculiar creaking or grating sensation is communicated to the touch. These bodies are often extremely numerous; Dupuytren believed them to be hydatids, and described their appearance minutely.† These tumours, after slight attacks of inflammation, often cease to fluctuate, and become filled with solid, unorganised fibrin; and when inflammation, followed by suppuration, comes on, which it usually does from using the hand in this state, I have squeezed out large masses of the coagulated substance through the opening made to let out the pus; this has been followed by the gradual subsidence of the abscess, and the perfect restoration of the use of the hand. Sometimes, however, the case takes an unfavourable course; diffuse erysipelatous inflammation is set up instead of that of a more plastic nature, and a fatal result will occasionally ensue. A patient was admitted under my care into St. George's Hospital with disease of this bursa. He was a publican, about fifty years of age, of a stout, flabby appearance, with failing pulse; the bursa, which had suppurated, had been opened above and below the wrist, and was discharging large quantities of pus mixed with the rice-like bodies in great numbers; the hand was enormously swelled, and the whole arm, extending above the elbow, enlarged, tense, and of a deep-red colour. The case in many respects resembled that of diffuse thecitis formerly described, and, like it, proved fatal, in spite of every means to support the system that I could employ.

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* On the diagnosis between diseases of the bursæ and of the joints, see DISEASES OF THE JOINTS.

† *Leçons Orales*, ed. 1839, vol. ii. pp. 148 et sqq.

A modification of the bursa is found connected with the extensor tendons of the fingers and toes; these are termed ganglions; their cavities do not appear to communicate with the sheaths of the tendons, but are formed in the dense tissue investing the sheaths or the capsule of the joint.* They form small round, movable tumours, rarely larger than a filbert, mostly at the back of the wrist; they are seldom painful, but the patient usually complains of a sense of weakness in the joint. They are found less frequently on the dorsum of the foot; here they present a more compressed form, and are less movable than in the hand. I have seen them on the outer part of the dorsum of the foot more than two inches in diameter, broad and flattened. These cysts contain almost constantly a firm gelatinous substance, nearly as dense as the crystalline lens of the eye. Ganglia do not, like subcutaneous bursæ, arise from pressure; they sometimes follow a sprain, but usually appear without evident cause; they are generally slow in their growth, but now and then appear quite suddenly.

Treatment of enlarged bursæ of tendons. These bursæ sometimes enlarge rapidly, under which circumstance they subside quickly by rest and evaporating lotions. The more common and chronic form of enlargement requires a more active mode of treatment. Sometimes a blister alone may be sufficient to cause their disappearance; this will be more effectual if the cyst has been previously emptied by puncture; and it may be advisable to keep the blister open. Compression after evacuation of the cyst may succeed in some cases. If they prove obstinate, they may be treated like a hydrocele, by injection of equal parts of tincture of iodine and water; this, however, should not be done in those bursæ which occasionally communicate with joints, nor perhaps in the bursa between the latissimus dorsi and scapula, for reasons already given. A seton often answers well, as in subcutaneous bursæ. The palmar bursa, when enlarged, as well as that at the angle of the scapula, requires some consideration as regards the health, powers, and condition of the patient before active measures are adopted for curing it; for it must be remembered that these measures effect a cure by setting up active inflammation and suppuration; and it has been already seen how prone the inflammation is to take on a diffuse and most unfavourable form, especially where the bursæ are extensive. Where the tumour is not of long standing, it may often be much diminished, if not cured, by puncturing it, which may be followed by either compression or blisters. In a patient under my care with inflamed thecal bursa (a nurse in the hospital), blisters were kept open for some time; after two or three successive punctures the tumours were much diminished and felt solid, the cyst containing evidently coagulated fibrin alone; she was now enabled to use the hand and attend to her duties. At the end of a few months, however, the hand became painful and inflamed, and fluctuation was perceptible both above and below the transverse ligament; an opening was made in each part, and a small quantity of pus escaped, mixed with fragments of coagulated fibrin. Seeing this, I enlarged the opening and squeezed out a large quantity of very firm straw-coloured coagulum; the cyst being emptied, a poultice was applied, and a generous diet ordered. Considerable discharge took place for some days, but gradually diminished; the wounds healed, and so complete was the recovery, that but for the marks of the incisions, no signs of previous disease existed. It has been recommended to lay open the entire sac, dividing the transverse ligament, and dressing the wound to the bottom with lint. This treatment one would hardly recommend, though where the rice-like bodies exist, simple punctures will not give exit to them, and incisions must be made for the purpose. In some cases both the seton and iodine injections may be employed, but with extreme caution. The ganglion may be treated in various ways; it is apt, however, to return. If the walls are not very dense, the sac may be ruptured by firmly compressing it with the two thumbs, or it may be divided subcutaneously with a tenotomy knife, or punctured with a grooved needle, and the crystalline contents squeezed out. Whichever plan is adopted, the swelling will probably return, unless further means be employed, such as a firm compression with a small solid body tightly bandaged over the part; or a blister may be applied over the part with a good effect. M. Boyer (loc. cit.) has described a case of very extensive ganglion connected with the extensor tendons of the fingers, which he dissected out and dressed to the bottom with lint, having previously failed in the treatment by seton and compression. The result of the operation was very favourable. These cysts, however, cannot be entirely removed by operation; the attached parts cannot be dissected from the tendon or ligament; so that they will return unless the wound be kept open to the last.

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* See Boyer, *Trait. des Mal. Chir.* vol. xi.

T. TATUM.

ORTHOPÆDIC SURGERY.

SINCE the labours of Stromeyer, published in 1831, an important class of affections, contractures and deformities, the treatment of which had previously, for the most part, been permitted to remain in the hands of the instrument-maker, has deservedly much engaged the attention of the Surgeon. Scarpa in 1803, Jörg, 1806, Rudolphi, 1823, Delpech, 1825, Dupuytren, and others, had, without much immediate fruit, endeavoured to remove the obscurity in which this class of affections was involved. Their inquiries happily served to direct the researches of Stromeyer into a proper direction.

The pathological nature of the affections relievable by orthopædic treatment, often by division of tendons (tenotomy), is various. They consist of alterations, in form and movement, of the articulations, especially of those belonging to the lower and upper extremities. They spring

1. From accidental injuries of articulations; undue pressure and strain; inflammation of joints or contiguous parts, particularly those succeeded by suppuration and its consequences.

2. From derangement of the cerebro-spinal system, leading to paralysis or spasm and contraction.

3. From congenital influences, the varieties of club-foot, for example; malformations.

Orthopædic Surgery comprehends, therefore, a multitude of abnormal forms of the muscular, ligamentous, and osseous systems, of which some are treated elsewhere in this work. On the pathology of deformities arising from diseases of the joints, the reader is referred to the essay on those diseases. Rachitic deformities are treated of in the essay on the SURGERY OF CHILDHOOD; spinal curvatures, in that on DISEASES OF THE JOINTS; strabismus, at vol. ii. p. 889; malformations, with the SURGERY OF CHILDHOOD; burn-contractures, above, p. 130. The affections which we have here to consider are principally those which can be remedied by division of tendons, by mechanical extension, or by both of these means combined.

Before proceeding with the description of the individual contractures relievable by tenotomy, it will be well to consider the circumstances which give rise to contraction and deformity, and to inquire into the condition of the muscles and tendons which renders their division necessary. It is now a well-understood law of pathology, that if any part of the body, into the composition of which muscles enter, be maintained in a state of absolute repose, or be habitually kept in one position, so that the origins and insertions of particular muscles are constantly approximated, whilst the points of origin and insertion of other muscles are consequently proportionately separated, a shortened, contracted condition of the first set of muscles, and an elongated, weakened state of the second set of muscles, are produced. This is illustrated by what occurs during a simple fracture or other injury of an extremity. If the elbow, for example, be for any reason retained a few weeks in the bent position, the muscles on the flexed side of the member become stiff and contracted, and are only gradually restored to their natural mobility by active and passive exercises and use, whilst the stretched out and weakened extensor muscles recover but slowly their full power of extending the implicated articulation. The state of things just described is aggravated when inflammation, exudation, suppuration, loss of cutaneous or more deeply-situated tissues, and consequent adhesions and cicatrices, interpose pain and physical obstruction to the restoration of complete mobility. The greater duration of the disorder increases the probability that persevering or active remedial means will be required to obviate the shortening of one set of structures and the elongation and weakening of the opposite set. This shortening and contraction occur more rapidly during the earlier years of life.

The influence of paralysis in producing contracture varies according to the nature and extent of the seizure. A single muscle, as the sterno-cleido-mastoideus, the tibialis anticus, or the external rectus of the eye, may be more or less completely paralysed; and the antagonist sterno-mastoid, the gastrocnemius, the peronei, or the adductor oculi, may become contracted. Or several muscles habitually associated in their actions may lose their power of voluntary contraction, as the extensors of the wrist and fingers; and the opposing muscles, also habitually associated in their actions, viz. the flexors of the wrist and fingers, become relatively shortened.

The demonstration of the precise amount and nature of the changes which occur in the central and peripheral parts of the nervous system, as far as apparent cause and morbid anatomy can teach us, and the determination of what particular functions of the muscles are primarily disturbed, belong to the special pathology of the nervous system, which need not here be entered upon. Few paralyses occur without some degree of contraction ensuing as a consequence, either directly from the impairment of the balance of muscular activity, or from forced repose or maintenance of the part in a particular position.

The induction by abrupt spasm of a more or less rigid, more or less permanently contracted state of a part, is obvious and easily intelligible; but the spasm which produces many persistent deformities is not always of that active, prompt, or tonic kind which is illustrated by certain cases of non-congenital wry-neck and club-foot, but is usually more slow and progressive, as seen in many children's cases of foot-deformity. The contraction in congenital club-foot and in the majority of congenital distortions can, we believe, be assigned only to a preternaturally excitable or spasmodic condition of the muscular fibres of the shortened muscles. In many cases, even when the shortened muscle has been set free by tenotomy, the morbidly excitable retractile disposition of the muscle often shows itself again after reunion of the divided part, and the cessation of employment of the mechanical or other means by which the affected muscle had been kept in an elongated state.

This contraction of certain muscles in congenital club-foot, which, for want of any other appropriate term, is designated spasmodic, is therefore very different from the active powerful retraction which occurs in certain comparatively sudden non-congenital cases, and in which the will of the individual is powerless to effect an improved condition of the limb. In congenital club-foot, and in analogous gradual non-congenital talipes in which paralysis does not exist, if the child is old enough to exercise volition, the affected muscles are to a certain extent subservient to the will, although volition is incapable of willing entire relaxation of the contracted muscles. Thus the contraction in this non-congenital non-paralytic talipes, the early stage of which we are able to watch, throws light on the congenital affection, the early stage of which is hidden in the uterus. In non-congenital cases of months' or years' duration, induced by cerebro-spinal affection or by reflex (?) disorder, the vital abnormal spastic contraction coexists after a time with secondary structural change. We sometimes, however, before structural change has taken place, have an opportunity of witnessing that, although the patient walks with the heel, for example, much elevated, yet when he is seated, even with the knee extended, he can voluntarily bend the ankle,—contact of the sole with the ground exciting abnormal contraction. Further light is thrown upon the nature of the contraction in congenital club-foot by the observation that, during sleep, even in very young infants, the affected foot can be more readily straightened; also that, like as in certain cases of adult hemiplegia, when the child yawns and stretches out the limbs, the inversion of the foot often disappears. This observation would show, that whilst in the ordinary state of the infant's nascent volition the adductor muscles (the tibiales) overpower the abductors (the peronei) and invert the member, the act of yawning, with its complicated reflex activity of inspiratory muscles and of associated muscles in the extremities, neutralises the peculiar disturbance of muscular activity on which talipes varus depends.

It seems as if in congenital club-foot and analogous distortions a stimulus or irritant were present in the medulla spinalis, acting upon certain ganglionic cells there, which keeps the affected muscle in a state of tonic contraction, yet not sufficient to neutralise the stimulus of the will within the limits of movement permitted by the structural shortening of the member. Many non-congenital spastic contractions appear allied to the condition which prevails in some states of chorea, in which, when the will would permit or cause contraction or relaxation of a particular muscle, an involuntary power of exciting contraction interferes and frustrates the voluntary effort. In more intense spasmodic contractions the will is entirely overpowered before structural shortening supervenes to effect the same end.

To resume, then:—clinical observation of non-congenital deformities, springing from derangement of the nervous system, teaches that there are several modes in which they are produced. These modes are as follows:

1. Paralytic distortions.
    - *a.* Certain muscles only being partially or wholly paralysed, their antagonists slowly contract the dependent articulation.
    - *b.* The muscles of the part in general being partially or wholly paralysed, the vital contractility of the greater mass, as of the flexors in the extremities, slowly contracts the dependent articulation.
2. Spastic distortions.
    - *a.* The contraction is severe and prompt, the will being quite overpowered or absent.

b. The contraction is gradual, as in the majority of (non-paralytic) cases of non-congenital talipes, the will not being neutralised (those reputed from teething, for example), but restricted by the morbid innervation, and in time by structural shortening.

c. The contraction is gradual but severe, as in the deformities which sometimes accompany imbecility in children. It is probable, in this form, that the contraction is intensified by the co-existence of an enfeebled condition of general volition, a general inertia, favouring repose of members, and a greater amount of structural change.

Secondary changes. From whichever of the above causes a constantly contracted state of an articulation or limb may have proceeded, the state of things, consisting of the inability of the individual to put the part, by the action of the will, through all its proper movements, is called a deformity. But if the patient by means of his own hands, or if the Surgeon, can overcome the contraction, and put the affected part through its proper movements, no deformity is in reality seen to exist. Positive deformity may early exist, when original disease of the joint has, besides producing contraction, ended in more or less considerable alteration in form and structure of the articulation. But almost equally serious (secondary) deformity may ensue through the influence of the now ill-regulated muscles of the joint, especially when these act upon tissues impaired by disease,—the production of sub-luxation, for example. In the lower extremity, the effects of the weight of the body being borne upon the member in improper directions is a very important cause of secondary deformity, adding greatly to the obstacles to restoration. Thus a not severe case of congenital club-foot, remediable in point of form in a few weeks before walking has commenced, may subsequently require treatment of months or of years; or, from the deteriorating cause above mentioned, be rendered irremediable.

We may now pass to the consideration of the means employed in Orthopædic Surgery for the rectification of deformities. This department of practice avails itself of much that is common with general Medicine and Surgery.* Special orthopædic means are, the relieving of the shortened parts by the employment of mechanical instruments, or mechanical power exerted by the hands of the Surgeon or assistants, sometimes with the aid of the benumbing influence of chloroform, and by division of one or more of the contracted muscles, tendons, and fasciæ.

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* Constitutional, medicinal, and dietetic treatment, exercises, gymnastics, inunctions, &c.

Tenotomy, myotomy. In this operation the necessary relaxation of muscular resistance and of accompanying structural shortening is effected by severing the muscle at its tendinous portion. The principles laid down by Delpech for the performance of this operation are followed in the present day. It is remarkable that Delpech never carried out his own principles.* The discovery and application of subcutaneous tenotomy belongs to Stromeyer. Many alterations in the mode of applying these principles have been made since the original labours of Delpech and Stromeyer. Various knives for severing tendons (tenotomes), and a great variety of mechanical extension apparatus, have been devised. In this place only the means in most general use in this country will be described.

In describing the several distortions in the treatment of which tenotomy and mechanical treatment may singly or conjointly be requisite, no nosological order will be adopted. We will commence with congenital club-foot (talipes varus congenitus), because it is one of the most common distortions which the Surgeon has to treat, and because it has formed the basis of extensive pathological and therapeutical research. The consideration of the scientific treatment of club-foot will, therefore, best illustrate the principles upon which the management of all other distortions should be conducted.

No other deformity exhibits in a greater degree the incidents of orthopædic experience.

Congenital Club-foot (*Talipes varus congenitus*).

It is undesirable to attempt here even a sketch of the history of the acquaintance of our profession with club-foot. It will suffice to mention that the subject engaged the attention of Hippocrates amongst the ancients, and of Scarpa amongst the moderns. But it was not until the genius and energy of Stromeyer were combined with a sound acquaintance with the principles and practice of modern Surgery, that the complete treatment of severe club-foot became possible.

Anatomy of club-foot. Former opinions on the anatomy of club-

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* See the history of division of tendons, in a *Treatise on Club-foot and analogous Distortions*, by the Author, London, 1839.

ot may be advantageously passed over.[*] In 1837, and subse-
uently, the author laid down the essential characters of the anatomy
f club-foot.[†] The subject has since been carefully and successfully
udied by Mr. William Adams.[‡] The general result of observa-
ons of this matter is the confirmation of the opinions emitted by
e author in 1837 and 1839,[§] that club-foot consists of a three-
ld alteration of the form and position of the foot, the heel being
evated, the toes turned in, and the internal margin of the foot
ised from the ground, owing to abnormal action and shortening of
e principal, if not of all the muscles of the inner and back part
the leg. Perhaps, also, in at least the severer forms, those in
hich the sole is much contracted, the plantar muscles participate
the primary affection. The ligaments, fasciæ, and integuments
the contracted side of the member are also shortened, whilst the
milar tissues on the opposite side are elongated and weakened.
ese passive tissues follow the fortunes of the active organs—the
uscles, on which they are in the main dependent, and become
us secondarily affected. The bones, before and after ossification,
ffer in proportion to the intensity of the muscular contraction,
d probably in proportion to the earliness of the period of uterine
istence at which the distortion commenced; and especially in
oportion to the period that elapses after birth, during which the
ssive osseous structures remain at the mercy of the active mus-
lar agents. The bones further suffer as age advances, by bearing
weight of the body in an improper direction.

The departure from the normal form and relation of bones may
divided into—

1. Primary.
    - *a.* The changes specially affecting the tibio-tarsal joint.
    - *b.* The change of relation of the anterior bones of the tarsus, as regards the astragalus and os calcis.
2. Secondary, or those induced after birth, by spontaneous aggravation of the deformity, and by pressure upon the parts through walking in an improper manner.

The anatomical changes of bones in varus of practical moment are due to the state of extension of the os calcis, taking with it the astragalus, through which the posterior extremity of the os calcis is more or less closely approximated to the posterior surface of the

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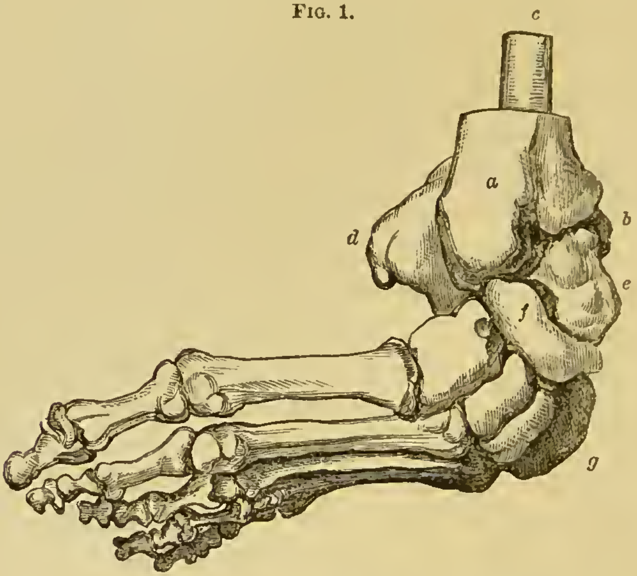
[*] See *On the Deformities of the Human Frame*, by W. J. Little, Lond. 1853,
271 et seq.

[†] *Dissertatio inauguralis de Talipede Varo*, Berlin, 1837.

[‡] *Medical Times and Gazette*, 1852; *Transactions of Path. Soc.*, 1856.

[§] *Treatise on Club-foot and analogous Distortions*, Lond. 1839. A large
nber of treatises on club-foot have appeared since 1837, few of which
tain any fundamental researches into the anatomy of varus.

FIG. 1.



Severe adult congenital Varus, viewed from the front and inside:—*a*, the tibia, cut down in order to show the relatively posterior situation of the fibula; *b*, the external malleolus; *c*, the fibula; *d*, the posterior extremity of the os calcis, drawn abnormally inwards; *e*, the astragalus, unduly prominent on the dorsum of the foot; *f*, the navicular bone in contact with the internal malleolus; *g*, the cuboid, its proper superior surface applied to the ground.

ankle-joint; and the anterior portions of the articulating surfaces of the trochlea of the astragalus are projected from the ankle-joint in front. Owing also to the forced inversion of the entire foot, the external malleolus is thrown backwards towards the posterior tuberosity of the os calcis, and the anterior extremity of the astragalus slightly inclines towards the inner margin of the foot. The forced elevation of the posterior part of the foot (calcaneum and astragalus) is common to talipes varus and to talipes equinus; but the characteristic peculiarity of varus is the displacement of the remaining bones of the tarsus inwardly to the extent that the navicular bone quits the astragalus, often touching the internal malleolus, with which it frequently acquires a new articulating surface. The cuneiform an cuboid bones accompany the navicula. Moreover, in severe case the cuneiform, cuboid, and metatarsals, with the phalanges, ar drawn backwards, limiting the space of the plantar region.

The changes of bones induced by improper walking, imprope pressure and bearing against the ground, by which also sometime inflammation and ulceration of soft parts are occasioned, do no properly belong to simple uncomplicated club-foot. Only whe hese injuries are considerable do they affect the results of treatment.

The shortening of the ligaments, fasciæ, and integuments on he posterior and internal aspects of the member may be observed when, before or after operation, attempts are made with the hand o rectify the deformity. In severe cases, much resistance to cure s offered by the posterior ligament of the ankle, the deltoid, the alcaneo-scaphoid, the superficial and deep plantar ligaments. The hare of resistance offered by the deltoid, for example, is well hown when dissecting severe infantile varus. After removal of he superficial textures (integuments, fasciæ, muscles, and tendons), much amelioration of shape results; but the ligaments of the ankle eing intact, it is observed that the foot still retains a varus form. But when the deltoid ligament is severed, and the navicular bone s liberated, a marked facility of replacement is evinced.

The general direction of the structures involved in the distortion is much altered. Thus, the leg-bones are inwardly rotated from the knee-joint. The Surgeon should not expect to find the endons occupying their normal relations. Those passing over the front of the ankle-joint are deflected inwardly, whilst the posterior ibial tendon appears more deeply situated, owing to the incurvation, the backward dragging, and elevation of the anterior part of he foot.

Etiology of congenital club-foot. The primary cause of talipes varus congenitus has been already touched upon, p. 559. It onsists in an alteration of the dynamic properties of certain muscles, apt to be accompanied or followed by structural shortening,[*] and by fibrous and adipose degeneration of them.[†] Until he researches of Rudolphi, it was held that club-foot, as well as ther distortions and malformations, were the consequence of some "occult influences," lusus naturæ, maternal imagination, and ntra-uterine pressure. An occasional effort is made to revive the ast of these theories, that of intra-uterine pressure. It has been lsewhere shown[‡] that accidental mechanical causes do sometimes ct upon the fœtus, giving rise to easily recognisable conditions, *g.* fissures, clefts, intra-uterine fractures, amputations of members rom constriction by abnormal bands or by the umbilical cord; nd sometimes the coöperation of pressure by the uterine walls nd pelvic bones may be surmised.

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[*] Little, loc. cit.

[†] Cruveilhier, *Anat. Pathol.*; W. Adams, *Pathol. Trans.* loc. cit.

[‡] *On Deformities of the Human Frame*, pp. 256-314.

The arguments in favour of the belief that ordinary congenital club-foot is caused by some derangement of the cerebro-spinal centres and dependent nerves, as opposed to the theory of its dependence upon pressure of the walls of the uterus, may be thus stated:

Club-foot often coëxists with evident derangement of the nervous centres, as in acephalous, hemicephalous, and spina bifida subjects.

Club-foot occasionally coëxists with an analogous distortion of the upper extremity, club-hand, in which the muscles contracted are the anatomical analogues of the parts contracted in the lower limbs. Now, if it be admitted that the external configuration of double club-foot may suggest to the unphysiological and unpathological observer the idea of one of the feet having overlapped the other in such manner that the uterus, *supposing* the liquor amnii to be deficient, has compressed the two feet into the form in which we see them, this explanation does not apply to the club-hands, which bear no such form as can be reasonably attributed to pressure of the uterine walls. Moreover club-foot often exists in one foot only, and the uterine-pressure theory does not explain why one foot escapes. This theory is still less applicable to the highest grade of club-foot, in which the great toe is more approximated to the inside of the leg than pressure of the uterus will explain; whilst the opinion of undue (spastic) action of the muscles before the articulating ends of bones can restrict their action, affords an intelligible explanation.

Club-foot is met with in fœtuses before the fourth or fifth month of gestation, at which period the liquor amnii is relatively so large as to exclude the idea of uterine pressure consequent upon *supposed* deficiency of that fluid.

Congenital club-foot can often be traced to hereditary influence, sometimes on the father's side, sometimes on the mother's side. We have traced it on the paternal side even through four generations, the male infant, the father, the grandfather, and the great grandfather. If it can be plausibly maintained that club-foot is due to the influence of uterine pressure, deficiency of liquor amnii, pressure of pelvic bones, and its repetition through successive generations, this influence could only be propagated through the female side. We cannot admit uterine influence in hereditary propagation of varus through an uninterrupted succession of male parents.

A comparison of club-foot with the distortions which occur after birth, unmistakably from diseases of the nervous system, tends to prove that congenital and non-congenital club-foot spring from analogous causes. Distortion after birth, from altered innervation of muscles, is more common in the lower extremities, and especially in the feet, than in any other part of the frame. Club-foot is also the most common distortion before birth. After birth, talipes varus, in consequence of cerebro-spinal affection, is more common than talipes valgus; before birth, varus is more common than valgus. After birth, foot-deformity, from disease of the nervous system, attains oftener a higher grade on the left than the right side. This is equally the case with congenital club-foot. Some other agency than accidental uterine or pelvic pressure is required to account for these analogies; they cannot be regarded as mere coincidences.

Grades of congenital talipes varus. It is convenient for practical purposes to divide congenital club-foot into three degrees of severity: the slightest, that in which the position of the front of the foot when inverted is such that the angle formed by it with the inside of the leg is greater than a right angle, and in which the contraction is so moderate that the toes can easily be brought temporarily by the hand of the Surgeon into a straight line with the leg, and the heel be depressed to the natural position. The second class includes those in which the inversion of the foot and elevation of the heel appear the same or little greater than in those of the first class, but in which no reasonable effort of the Surgeon's hands will temporarily extinguish the contraction and deformity. The third class comprises those in which the contraction of soft parts and displacement of hard parts reaches the highest degree, so that the inner margin of the foot is situated at an acute angle with the inside of the leg, sometimes is even almost in contact with it.

Cases of the first and second grades may be respectively converted into the second and third grades by delay in the application of remedies, and by the effects of improper locomotion.

Treatment. The indications are to overcome the shortening of the muscles, ligaments, fasciæ, and integuments on the contracted side of the member; to direct the bones into their proper position; to give strength to the muscles and ligaments on the elongated side of the member, and to combat the tendency to relapse.

A few slight cases may from the day of birth almost be relinquished to the rubbings and manipulations of the nurse; some require to be lightly bandaged on a strip of tin or firmer metal, bent to a right angle, and properly padded; others require support not only beneath the sole, and against the back of the leg, as when a simple bent strip of metal is employed, but need lateral support or pressure against the internal margin of the foot, as by the application of a tin splint devised many years ago by the author (see *Treatise on Deformities*, fig. 113). In the use of this and similar contrivances to be found at the different surgical instrument-makers, the essential point consists in applying the smallest amount of pressure compatible with maintaining the apparatus on the limb, not endeavouring at once either to force the part straight, or even to make the tender infantile foot accurately fit the apparatus, but rather, if the apparatus selected admits of adaptation, to adjust it to the foot in a somewhat improved position. Practitioners unacquainted with the details of management of these cases are surprised to discover how small an amount of pressure suffices in young infants rapidly to improve the form and flexibility. The splint should daily once, or oftener, be removed to ascertain that undue pressure has not been used, to replace it when loosened by the movements of the child, and to improve the position as often as practicable. No unnecessary loss of time should be permitted during this process, as at first the foot rapidly relapses to its most distorted condition.

If at the expiration of the fourth week distinct contraction of the tendons remain perceptible in spite of assiduous efforts to overcome the deformity by manipulations, frictions, and steady but gentle employment of splint and bandage, or if benefit proportionate to the attention bestowed be not realised, or if the case unequivocally belongs to the second or third degrees of varus, the aid of tenotomy will be required to effect restoration. If the Surgeon should entertain doubt whether the time for operation have arrived, he may be determined by the observation whether, on holding the foot in the normal position, it springs vigorously back into the abnormal one as soon as the pressure of the hands is removed. In unequivocal cases of the second and third degrees he may, in most cases, decide affirmatively at the moment of birth on the absolute necessity of future operation. In this decision he must not be guided solely by the external configuration, but by the amount of firm resistance opposed to restoration, by the depth of the furrows existing in the sole and behind and above the heel, and by the degree of tension of the integuments about the internal malleolus. The deep clefts or furrows in question denote intensity of contraction of muscles, and closer adhesion than usual of integuments and fasciæ to the subjacent soft structures and bones. They probably denote also that the deformity dates from an early period of uterine existence. Even atrophy, the usual concomitant of contractions of long duration, is already present in severe club-foot of new-born children, and is a measure of the length of time the muscles have been contracted and exposed to structural shortening and possible degeneration.

Nature of the operation. The essential character of congenital talipes varus being a state of abnormal elevation of the heel, and inversion of the front part of the foot by undue muscular contraction, the operative interference required consists of the division of the tendons of those muscles which are mainly, if not exclusively, concerned in the production of the deformity, viz. the tendo Achillis and the tendons of the anterior and posterior tibials. In average cases these three tendons may be divided at one operation. In severer cases the operation may be advantageously divided into two parts, the first consisting of the section of those structures which contribute to the inversion—the tibiales tendons; and where the sole is much contracted with a strong prominent band felt at the inner edge of the plantar fascia, that band may be included in this portion of the operation. The tendo Achillis may, in such cases, be severed in three or four weeks; in adults, two or four months later; the inversion having, in the interval, been overcome. The value of this proceeding, first recommended by the author,* consists in the os calcis, when the tendo Achillis is left intact, offering a point d'appui, or resisting point, from which the Surgeon, during the mechanical after-treatment, is enabled to stretch out and unfold the contracted involuted sole. If this division of the operation into two parts is not observed in bad cases, incomplete recovery may result, the sole remain contracted, and the individual walk unduly on the heel, range of motion of the point of the foot being deficient,—in short, a secondary talipes calcaneus be produced. This secondary deformity is always overcome with difficulty; sometimes it is irremovable.

The following is the mode of dividing these tendons, and the instruments which we have introduced as the most appropriate for the purpose. The operation is more quickly and more conveniently done by taking the three tendons in the following order, viz. the posterior tibial, the anterior tibial, and the tendo Achillis. Section of the posterior tibial is best performed by placing the child on a table of convenient height, on its back, inclined towards the limb to be operated on. This should be thoroughly rotated outwardly, resting upon its outer side, whilst a competent nurse holds the child's hands and the opposite leg out of the way of the Surgeon. An assistant, having a few small dossils of lint, a bandage, and the necessary knives within reach, takes his place by the side of the patient, and holds the thigh and knee of the limb to be operated on with one hand, being prepared with the other to hold firmly or abduct the foot, as may be required. The operator, when about to sever the left posterior tibial, seats himself in front, takes the foot in his left hand, and endeavours to feel the slight prominence of the posterior tibial tendon with the left thumb; during the time he either abducts the foot with the right to put the tendon on the stretch, or takes advantage, during the spontaneous movements of the infant, to observe where the tendon is thrown into palpable relief.

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* *Lancet*, May 25, 1839.

When, however, the Surgeon cannot feel the tendon, it is practically quite sufficient to make out the inner edge of the tibia, about a finger's breadth above the lower end of the inner malleolus; or should there be any difficulty in defining this ridge of bone in consequence of the fatness of the limb, the careful insertion of the knife *exactly midway between the anterior and posterior borders of the leg*, on its inner aspect, will be a true guide to the position of the tendon, not forgetting, as anatomy teaches us, that an incision made a little in front of this line might wound the internal saphena vein and nerve; and if made behind it, would run the risk of dividing the flexor communis digitorum instead of the tibialis posticus; or the knife might even pass posterior to the former tendon, and, if carried deep enough, might wound the artery and nerve without touching any tendon whatever.

Having thus determined the exact situation of the posterior tibial by one or all of these methods, a sharp-pointed knife is passed through the skin at about a finger's breadth above the inner malleolus, according to the age of the child. It must be made to penetrate steadily down, *perpendicularly to the surface*, to a depth varying from a quarter to half of an inch. In doing this, it is necessary to be quite sure of sufficiently opening the fascia covering the posterial tibial and common flexor tendons; otherwise, when the probe-pointed knife is passed in (as will be described in the next stage of the operation), it may either hitch against this dense unyielding structure, or glide over its surface behind the deep layer of muscles, instead of passing through the opening in front of them.

In order, therefore, to accomplish the *free division* of this fascia of the leg close to its insertion into the edge of the tibia, and likewise the proper sheath of the posterior tibial tendon beneath, the sharp-pointed knife should be passed to the depth above recommended; the handle must then be elevated so as to depress the point of the blade; that is to say, the instrument should be used as a delicate lever, the centre of motion being the skin, which may be pressed upon gently by the back of the knife; and in this way an opening of the requisite size can be made in the fascia at the bottom of the wound, without enlarging the external aperture.

Having thus far accomplished the operation, the sharp-pointed knife is withdrawn, and a probe-pointed one is to be passed into the puncture through the skin, superficial fascia, layer of adipose tissue, deep fascia, and lastly the proper sheath of the tendon, and be now inserted a little further in, so as to get well between the posterior tibial and the tibia. When satisfied from the sensation communicated to the knife that the bone is on one side and the tendon on the other, all that remains to be done is to turn the edge towards the tendon, giving the knife a slight cutting motion, while at the same time the assistant firmly abducts and depresses the inner border of the foot.

A distinct sensation of something having suddenly yielded can be perceived at the time of the division of the tendon; but if the case should have been previously operated on, this feeling may be very slight, in consequence of the adhesions existing between the original wound of the tendon and the adjacent parts.

As soon as this peculiar jerk is detected by the assistant, he should immediately relax the foot, and apply a dossil of lint over the wound, holding it there with the fore-finger during the division of any other tendons. If the artery is supposed to be cut, either from the sudden escape of florid blood or from the marked blanched appearance of the foot, it will only be necessary to apply instantly a graduated compress, and to roll firmly a bandage upon the foot and ankle. This, however, may require to be loosened if the colour of the toes shows any indication of strangulation. If the operator is not ambidexter, he will find, in the operation for dividing the posterior tibial tendon of the right limb, that he had better stand on the left side of the patient with his back to the patient's face, whilst the assistant sits down in front, and holds the thigh with one hand while he steadies the toes with the other.

Taking, then, the mesial line or the inner aspect of the leg at about three-quarters of an inch above the inner malleolus as the true position of the tendon, the sharp-pointed knife is to be inserted perpendicularly, with its back towards the sole of the foot. It is thus made to divide the skin and deep fascia in the same way as was explained when cutting the left posterior tibial tendon. After this instrument is withdrawn, the probe-pointed knife may now be used to finish the operation, which in all other respects agrees with the section of the corresponding tendon on the opposite side of the body. The long flexor of the toes, owing to its proximity, is often partially or wholly severed at this operation on the posterior tibial.

Weis and Velpeau divide the posterior tibial tendon at its insertion into the navicular bone, the knife being inserted so as meet the tendon about an inch (in the adult) below and in front of the inner malleolus. This plan is inapplicable to infants. In adolescents and adults this tendon is usually so prominent to the eye and touch above and behind the internal malleolus, that it is an easy matter to sever it by inserting the point of a narrow straight scalpel at the posterior edge of the tendon, directing it forwards between the tendon and tibia, so as to divide it without risk of injury to the posterior tibial artery or the internal saphena vein. It is unnecessary to give particular directions for division of the plantar fascia when needed, those given respecting operations on tendons being amply sufficient. The direction of the knife should be from without inwards, *i. e.* from the external margin of the foot towards the internal margin.

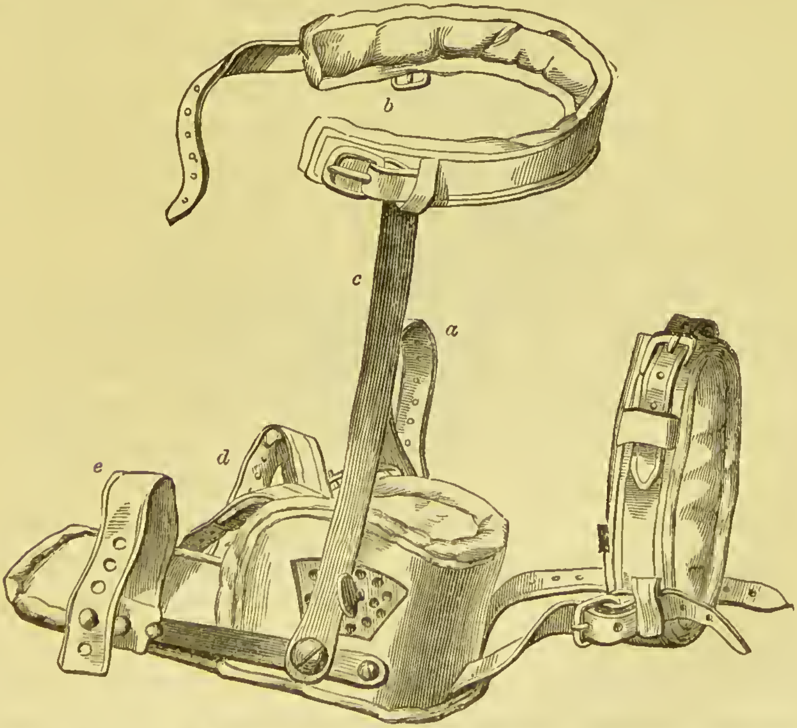
The division of the anterior tibial tendon in talipes varus should follow the section of the posterior tibial; the patient being in the same position, and the assistant still holding the limb, and pressing his finger upon the lint covering the puncture already made above the ankle. The operator should feel for the most prominent part of the tendon over the joint, somewhat nearer the malleolus than in the normal foot, and insert a sharp-pointed knife, with its flat surface towards the outer edge of the tendon; and having passed it well beneath, he should turn the sharp edge towards the tendon, whilst the fore-finger of the left hand is pressed gently over the part, to warn him of the approach of the knife to the surface. The assistant, who has been steadily abducting the foot during the operation, gradually relaxes his endeavours as he feels the tendon yield; and so soon as he perceives the distinct snap which is the result of its complete division, he should immediately relax his hold, and apply a small dossil of lint over the puncture.

Division of the tendo Achillis is accomplished after turning the infant over on the abdomen. Whilst an assistant endeavours to bend the ankle, the Surgeon introduces a small straight tenotome through the integuments from behind forwards at the side of the tendon. As soon as the point of the instrument is judged to have reached the anterior surface of the tendon, it is passed in front of it; the cutting edge is then directed to the tendon, severing the tense cord by one or two movements of the blade against it, and without wounding the integuments, except by the puncture of entry. The assistant should carefully relax the pressure he may be exercising upon the foot in proportion as he feels the part is cut through.

These operations, when properly done, occupy not more than a few seconds each, and are usually absolutely bloodless. Much has been written concerning the danger of wounding the posterior tibial artery. In the most experienced hands this vessel and the posterior tibial nerve may be injured. I have only once witnessed any trouble from the circumstance. This accident occurred to a former colleague. Ligature of the vessel on account of a small filbert-sized aneurism was required the third week after the operation. In that instance the wound in the vessel would have probably healed without aneurism if the Surgeon had not too soon after the accident incautiously removed the bandage and abducted the foot. When injury of the vessel is suspected or known to have occurred, the removal of the bandage and commencement of the mechanical after-treatment should be delayed three weeks.

Apparatus required after operation. The metal splints already

FIG. 2.



Dr. Little's Shoe for Varus of left foot:—*a*, strap to be attached to the buckle *b*, intended to moderate the action of the lever-spring *c*; *d*, two straps which start from within the heel-piece on the outer side of the foot near the sole-piece, and are intended to be secured to buckles on the opposite side of the instrument, for the purpose of holding the posterior part of the foot firmly against the inside of the shoe, whilst the strap *e*, and short spring to which it is attached, draw the front of the foot outwardly. The convalescent may take exercise in this apparatus.

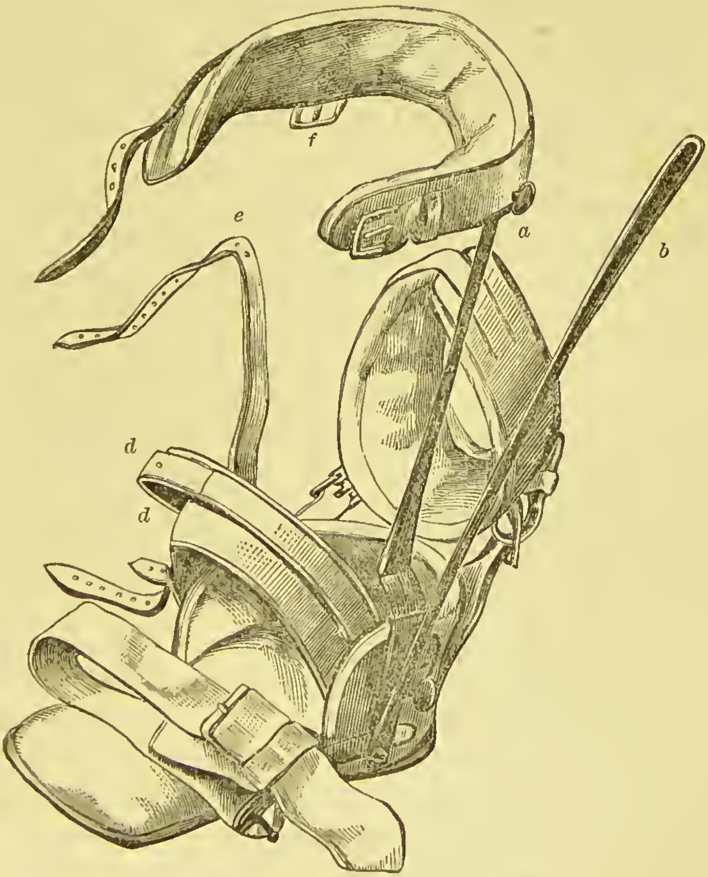
recommended for cases relievable without operation are equally applicable after division of tendons. Three days after operation, one of these splints, not much straighter than the affected foot, should be selected, or if a splint capable of being adjusted by a screw be used, it should be set at an angle or in a direction that the child will bear without complaint. In infants above the age of two of three months, a more elaborate and effective apparatus may be employed, when the pecuniary circumstances of the parents permit it. The woodcut, fig. 2, represents the lightest, the most effective, and the most inexpensive of the more elaborate apparatus constructed for the purpose. The perpendicular lever and the toe-spring are derived from Scarpa's shoe; but as Scarpa's apparatus contains no contrivance for depressing the heel, but relies simply on the effect of the weight of the body acting during locomotion, the author has introduced the movable thumb-screw, capable of being inserted into any required hole of the quadrant shown as above. This is an improvement upon the male and female screw, and the double-acting ratchet-screws often used for the purpose. The simple arrangement of a movable thumb-screw has, in addition to lightness, the advantage of permitting mobility of the ankle in the direction of bending,—a circumstance of much importance.

Cases of the first grade of infantile deformity are usually rectified in two or three weeks, those of the second grade in about four weeks, and those of the highest grade, the operation and the mechanical treatment having been divided into "deux temps," within two or three months. The treatment of adolescents and adults varies from two to twelve months.

Relapse not rarely occurs after the most complete flexion and abduction has been obtained. It takes place insensibly, at all ages, especially when growth is most rapid, and is due to too early discontinuance of instruments, and to neglect of manipulations and of passive and active exercises. The worst so-called relapses result from previous incompleteness of operation or of restoration. No case should be considered finally cured until the mental development of the patient is sufficiently advanced for him to take an interest in his cure, and to be able voluntarily to hold the part in a perfect position, and perform the natural movements of it. In relapsed cases repetition of tenotomy is not commonly required. Often the tendo Achillis will be found of ample length; sometimes the diminutive belly of the muscle, wasted through want of the stimulus of adequate alternate flexion and extension,—*i. e.* proper exercise,—being shortened and drawn up towards the popliteal region. It is less easy to determine whether the posterior tibial requires redivision; the tension of its tendon, the degree of relapse, and especially the degree of elevation of the internal edge of the foot, will assist the judgment. Continuous gentle re-application of the extending apparatus, aided, as soon as flexion to the right angle is reached, by exercise with a wedge of cork beneath the front of the sole, suffices to restore these cases usually within a few weeks,—*i. e.* within the period the patient would have been required to lie up if tenotomy had been repeated. It is satisfactory to be able, not only to spare the patient and friends the concern incidental to any operation, but to be able to avert, by mechanical means only, without loss of time, the discredit which attaches to the repetition of the operation.

In the treatment of relapsed adolescents, an apparatus that will

FIG. 3.



Dr. Little's double-hinged upright Shoe for severe rigid Varus of left foot:—*a*, stiff upright, hinged in two places, which when applied to the leg adapts itself to any degree of deformity; *b*, a spring curved outwardly, which when brought into contact with *a* can be then secured by means of a swivel-stud; *d d*, two straps for purposes similar to straps *d*, in last figure; *e*, moderating-strap, to be secured to *f*, as required. If the act of bringing the spring *b* into contact with *a* should occasion too much strain, *b* can be fastened at any required distance from *a*, by means of a tape. In the application of a varus shoe, success depends much upon the nicety with which the sole is applied to the sole-plate of the apparatus, and upon careful adjustment of the power employed. The foot-part of the shoe should be properly applied before the upright lever is secured. The moderating-strap is the last to be fastened.

bear the risks of walking exercise, and at the same time favour mobility of the ankle-joint in the required direction, is afforded by fig. 3.

After operation for club-foot, even in infants, continuous application of splints or other apparatus is required for four or five weeks; in older children, for two or three months. The less severe the case, the more often the apparatus may be removed for cleanliness, and to examine lest undue pressure is employed. It is the boast of successful treatment of club-foot to be able to accomplish this result without a single excoriation. The Surgeon should watch that, in his efforts to depress the heel and abduct the foot, the part be not too long maintained in one position, to the extent that the power of lowering the toes and of inverting the foot is lost; or, in other words, a valgus be engendered in exchange for the varus. This secondary valgus has been attributed to the non-union of the severed posterior tibial tendon. It is really due to too long-continued retention of the foot in an abducting apparatus. We have witnessed it in children born with varus, who had been treated without operation. Its production is favoured by the same constitutional debility which produces spurious valgus, or flat-foot, in rapidly-growing children, who have previously had perfect feet.

Instrumental treatment is further required during at least a portion of each twenty-four hours, until the individual is enabled to plant the entire sole evenly and properly upon the ground, to thoroughly flex and extend the part at will, and habitually, when walking properly, to evert the toes. In numerous cases a child requires no apparatus after the age of five or six months; but the majority need some instrumental aid, such as leg-irons to evert the entire extremity, until the intelligence is sufficiently awakened,—say, until the age of three years. The maintenance of the "cure" depends, as in all diseases, greatly, if not mainly, upon the individual or his natural guardian. We have had cases under observation off and on from infancy to puberty, owing to successive relapses, which have more commonly occurred abroad or in the colonies. We have witnessed examples of adults returning to be re-operated, who have been successfully referred to their own efforts, with a few instructions as to mechanical attention.

After tenotomy no replacement of the part should be attempted until after the puncture has cicatrised. Much has been written respecting the propriety of immediate replacement. It is unnecessary in slight cases, and impossible in severe ones. In slight cases, nothing is gained by it; for if the position may be immediately rectified, the part cannot be immediately used. The limb should therefore be gradually replaced while the tendon is consolidating itself.

The influence, in interfering with union, of too-considerable and too-early separation of the ends of a severed tendon, and especially of frequent motion, as in walking, is incontestable. Experiments upon animals have proved that considerable lengths of tendon may be excised, and union nevertheless ensue; but the knowledge possessed of the great extent of the powers of the economy is an insufficient reason for neglect of those rules of caution which experience dictates. The immediate separation of a severed tendon to too great an extent should be avoided. Half or three-quarters of an inch may be safely borne, although as a rule gradual separation is preferable. The condition of a severed tendon approaches that of a fractured bone; too great separation of the severed ends, depression of temperature sufficient to suspend active arterial circulation, too-early movement of the parts, and inherent vice of constitution, may cause tendon, like bone, to remain ununited.

Stromeyer has suggested, that previously to operation the patient should be accustomed to wear the replacing instrument. This plan is desirable when the practitioner is unfamiliar with the treatment of deformities; for he thereby becomes versed in the action and mode of application of the apparatus, and is rendered certain beforehand of the appropriateness of the contrivance.

With reference to the choice of the apparatus, Stromeyer has rightly remarked, that every practitioner will select that of which he best understands the action and mode of application. This sagacious observation explains also one cause of the zeal with which each writer advocates his particular appliance.

It cannot be too strongly insisted upon, that in a large number of deformities, whether treated with or without operation, expensive instruments are unnecessary. More depends upon the tact, patience, and perseverance of the practitioner than upon the apparatus employed. Common roller bandages, tin, wood, or gutta-percha splints, aided by manipulations, may, in ingenious hands, supply the place of the most elaborate contrivances.

It may sometimes happen that no instrument is available, and the after-treatment may require to be conducted entirely by manipulations. Thus an adolescent case of double congenital varus was admitted into the London Hospital, under the care of Mr. Critchett, which had been rejected as incurable from another hospital on account of large ulcers with necrosis on the dorsum of each foot, induced by pressure during the mechanical treatment after tenotomy. As the unhealthy character of the ulcers depended upon want of air and exercise, and the application of suitable instruments was impossible, it was determined not to wait for cicatrisation of the ulcers, but to repeat tenotomy, and effect forcible manipulations of the members. Chloroform was upon one occasion employed. By these means the feet were gradually straightened, cicatrisation of the ulcers was thereby favoured, and within three months the lad quitted the hospital entirely restored.

After congenital varus, as after acquired deformities, retentive apparatus may be required ; these for the most part consist of jointed irons to support the weak articulations, and springs to assist the action of the debilitated muscles.

The completeness of recovery in the great majority of the cases of congenital varus constitutes one of the triumphs of surgical art.

During childhood congenital varus may be entirely cured, without other traces of deformity than smallness of the member, greater squareness of the front of the foot, and sometimes less complete mobility of the ankle-joint, the patient recovering entire volition. When the case is unattended to before adult age, the internal margin of the foot may never be completely applied to the ground, owing to the impossibility in some cases of perfectly unfolding the os cuboides from its inferior and rotated position in the tarsus ; in other instances, owing probably to the round head and neck of the astragalus having become so much inverted in relation to the remainder of the bone, that part of the undue convexity of the tarsus outwards becomes irremediable. Every year reduces the number of adult cases of varus requiring treatment, so that the consideration of any means of meeting the attendant difficulties may appear superfluous. The author has usually found a most efficient agent in a firm pad placed in the sole beneath the os cuboides, pressure being at the same time made upon the upper surface of the other tarsal bones.

Congenital Talipes equinus, Talipes valgus, Talipes equino-valgus, and Talipes calcaneo-valgus.

By talipes equinus is understood morbid contraction of the muscles of the calf, and consequent depression of the toes, the adductors being unaffected. This is a very rare *congenital* affection. We have met with two cases in the same family,—the first born and the last child, the eleventh. When it has not been treated in infancy, locomotion is effected on the inferior extremities of the metatarsal bones and phalanges. In severe cases the internal margin of the foot is slightly inclined inwardly, and the metatarsus is projected forwards. There is not, as in varus, any disposition to tread exclusively on the outside of the fifth metatarsal bone.

The existence of congenital talipes equinus has been emphatically denied. It is a question of fact and capability of discrimination. It may be suspected that the rare cases of congenital equinus which may have fallen under the observation of those who have denied its existence have been erroneously classed as varus. In congenital contraction of the muscles of the calf, owing to the morbid elevation of the heel, the narrow portion only of the trochlea of the astragalus is retained within the malleoli, and the front of the foot falls or is drawn readily either inwardly or outwardly; the more ready or usual direction being inward; just as we see in sound children there is a preponderance of the adductors (tibiales) over the peronei, and the feet are consequently observed to be turned in more often than out. Consequently the Surgeon, who makes no allowance for the ordinary tendency of the feet to incline, and who considers a case to be varus when he sees the foot with never so slight an inward inclination, does not believe in the existence of congenital talipes equinus.

The few cases of unoperated congenital adult equinus which we have seen have remained talipes equinus throughout. The patients have continued to walk on the metatarsal extremity of the great toe, as well as on the little toe. The great toe has never been raised from the ground, as it is in congenital varus. No original or secondary affection of the adductors had drawn the foot in, so as to resemble congenital varus or even non-congenital equino-varus. The patient, we repeat, still walked on the great toe and the little toe.

If congenital equinus be rejected upon the ground that must be taken by those who deny its existence, then it may as justly be asserted that neither does non-congenital talipes equinus exist; for there is no non-congenital talipes equinus in which a trace of inversion or of eversion cannot be discovered, which when very marked is termed either talipes equino-varus or talipes equino-valgus.

The dispute as to the existence or non-existence of congenital talipes equinus continues for the same reason that discussion is endless in every department of natural history, as to whether a given object belongs to one species or forms another species; one observer recognising a radical difference, which another observer either overlooks or explains away as belonging to another species.

Talipes valgus, equino-valgus, and calcaneo-valgus, are the terms applied to those distortions which contrast most with talipes varus, or ordinary club-foot. The front of the foot is more or less turned out in each of these varieties, instead of being inverted as in varus. In valgus the peronei are the muscles mainly contracted; in equino-valgus the tendo Achillis is also tense, and the heel elevated, the toes at the same time pointing outwardly. In calcaneo-valgus the heel is depressed through the contraction of the anterior tibial, and the toes pointed outwardly from tension of the peronei.

The rules already laid down for judging of the necessity for tenotomy in varus and of the number of contracted tendons to be divided, apply to each of the distortions now under consideration. The principles which should direct the mechanical treatment are equally applicable. The experience of the Surgeon and the ingenuity of the instrument-maker are required to adapt the apparatus to the peculiarities of each case.

A variety of congenital varus occasionally presents itself, in which the inner margin of the foot is slightly raised, the sole contracted, and the dorsum prominent towards the outer side of the foot, but without elevation of the heel. In these cases the muscles of the ankle are unaffected. We have designated this affection calcaneo-varus. The treatment consists in making pressure by means of a pad upon the prominent dorsum, and in suitable manipulations. A beneficial result is soon observed; but the affection is prone to return.

Some irregular congenital foot-distortions are met with. In a few of these we find distinct paralytic loss of muscular power: in one case well-marked paralytic varus, with much atrophy of the soft and hard parts; in another, paralytic contraction of the hips, knees, and feet, with implication of the upper extremity. The only treatment applicable is to relieve contraction by tenotomy, thus offering a chance to the muscles which remain partially under the will, to support the individual in attempts to effect imperfect locomotion. We have watched these cases from birth to adolescence; the paralysis has remained undiminished.

Distortions originating at the moment of Birth.

We have seen that in the earliest times of the study of congenital distortions, they were successively attributed to the anger of the Deity, lusus naturæ, malposition in, and pressure of, the uterus. In the present day, an enlarged observation of non-congenital as well as congenital distortions leads irrefragably to the conclusion, that the numerous causes which are found to operate in the production of distortion after uterine existence, exercise analogous if not identical effects whilst the fœtus remains within the uterus. These causes are, hereditary and maternal influences, disturbance of the nutritive, respiratory, circulatory, and nervous systems of the fœtus and infant, accidents, entanglement by the funis and abnormal bands, intra-uterine fractures, malposition and pressure, fixed repose in one position, and inflammation. In order to illustrate the obnoxiousness to distortion existing at every epoch, we shall here describe a group of distortions, which unquestionably take their origin at the period intervening between uterine and independent life, that is, during birth. We believe we can particularise the moment, as that moment which connects placental with pulmonary respiration. When we reflect upon the important phenomena in the economy at the moment when it should adapt itself to the immense changes involved in the abrupt transfer of the oxygenating process of the blood from the placental to the pulmonary cell-surfaces, we should anticipate that any retardation, interruption, or arrest of this transfer of the most important function should be attended with the greatest evil to the system at large, and especially to the nervous system, the most susceptible in the body.

We know that a state of suspended respiration and animation is the common consequence of many of the accidents attendant upon birth; and we might infer, from the evils often witnessed after recovery from the asphyxia of drowning or of choke-damp, what might be the consequences of the asphyxia of new-born children. Some of these appear, however, to have escaped notice, until the observations published by the author in 1843. The lungs suffer in the form of atelectasis; the heart probably in delayed or deficient closure of the foramen ovale, and possibly in straining of its walls; the nervous centres from effusions and apoplexy, followed by impeded developments, atrophy of individual parts, impaired intellect and volition, spasmodic convulsions, and spasmodic contractions.

It is scarcely necessary to add, that difficult and instrumental labours, and those in which the cranial bones and brain, and even the vertebræ and their contents, have suffered mechanical injury, are more likely to be followed, if not by death, at least by serious derangement of the nervous system, of which a prominent symptom is "internal" or subdued convulsions.*

The class of affections resulting from injury at birth, whether mechanical or vital, consists of diminution of volition with tonic rigidity, in varying degrees, of a part or of the whole of the muscles of the body. Both lower extremities are more or less generally involved. Often one limb only is referred to by the parents; but careful examination usually shows a smaller degree of impairment in the limb supposed to be unaffected. The amount of contraction in the hips, knees, and ankles is often considerable, and the leanness proportionate to the contraction. The flexors and adductors of the thighs, the flexors of the knees, and the posterior muscles of the legs preponderate. The thighs and knees cannot therefore be completely extended, or the heels be applied to the ground. The upper extremities are sometimes held down by the preponderating action of the pectorals, teres major and minor, and latissimus dorsi; the elbows are semi-flexed, the wrists partially flexed and pronated, and the fingers incapable of perfect voluntary direction. Participation of the muscles of the trunk is sometimes shown by the shortened, flattened aspect of the pectoral and abdominal surface, as compared with the more elongated, rounded form of the back. The prominence of the back partially disappears on recumbency; but the greater weakness of the muscles on the dorsal aspect of the trunk is obvious when the individual again attempts to sit upright. The inability and indisposition to exert the abdominal and other muscles concerned in the expulsive processes may, perhaps, sufficiently explain the tendency both to rare micturition and defecation, which sometimes exists. The muscles of speech are commonly involved, the affection varying in degree from inability correctly to utter one or more letters of the alphabet, up to the entire loss of the articulating power. During the earliest months of life, deglutition is often impaired. The intellectual functions may suffer from the slightest impairment, which the fond parent unwillingly acknowledges or fails to perceive, up to entire imbecility or idiocy. The functions of organic life are unaffected, except perhaps that of development of calorie, although the depression of temperature may be more dependent on the want of proper exercise. The appetite is good; the frame generally, in average cases, is well nourished, although free from adipose deposit. The child is often described as the healthiest of the family, escaping epidemics, or having these disorders less severely than the brothers and sisters. These subjects often lead a more precarious existence during the first weeks after birth; at first even vegetative life languishes, often because premature birth or difficult labour, by impairing the maternal supply of nutriment, renders more difficult the infant's recovery from the shock the system has received. However, in the majority of instances, after restoration of the vegetative functions, a gradual amelioration of all the functions of animal life is perceptible.

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* See *Transactions of the Obstetrical Society*, 1862.

The contractions are not present, or are not observed, until some weeks after birth. The child's limbs are simply weaker; the question of viability alone occupies the thoughts of the attendants. Before the age of three or four months, though sometimes in slight cases not until the ordinary time for locomotion has arrived, the nurse perceives that she is unable properly to separate the thighs or knees for purposes of cleanliness; that the child never thoroughly straightens the knees; that he does not attempt to stand, or is incapable of standing except on the toes, or that the feet are disposed to cross each other. Even children slightly affected rarely "go alone" before the age of three or four years; many are unable to raise themselves from the ground at that age, and others do not walk even indifferently at puberty. Locomotive ability seems to advance in proportion as the intellectual powers are developed. The external form of the cranium occasionally exhibits departure from the normal type—such as general smallness of the skull, depression of the frontal or occipital region only; sometimes of one lateral half of the skull, sometimes of one half of the occiput only. In slight cases the head has been well developed. The ensemble of phenomena points to injury more or less extensive of the cranial contents, and of the medulla oblongata and spinalis.

In all cases, even with great inertia as to the exercise of volition, common sensibility appears little if at all deficient. On the contrary, a morbid sensibility of the organ of hearing and of the cutaneous envelope appears to exist, evinced by "startling" at the slightest noises, and extreme sensibility to touch. This morbid sensibility may be due to a condition of spinal cord analogous to that present in narcotized frogs, in individuals under the influence of strychnine, or those affected by tetanus. It may, however, be apparent only, dependent upon the individual, when subjected to common noises, being less competent quietly and promptly to reason upon them, and, by thus reassuring the perturbed mind, to escape from the exciting influence. In many cases the intellect has been intact. A peculiarity of these children—an uncommon fear of falling—is often observed when they are seated on a couch, less when they are on the floor, and not observed when they are seated in an arm-chair; a circumstance clearly due to conscious inability to balance and recover the position of the body.

Spastic Contractions from Cerebro-spinal Disease in Infancy and Childhood.

We have just described a state of more or less general spastic contraction, which results from disturbance of the cerebro-spinal centres at the moment of birth, either from direct injury to the cranium or neck whilst passing through the maternal parts, or, more probably, from asphyxia consequent upon interruption to the substitution of pulmonary for placental respiration. Sometimes, without either premature or difficult labour having preceded, convulsions occur very soon after birth, during the first hours, days, or weeks of independent existence. Convulsions, as is well known, occur more frequently after dentition has made some progress, whilst the infant is undergoing another transition, that of passing through the crisis from nourishment by the mother's breast to feeding, when unfavourable consequences of deprivation of breast-milk are apt to show themselves. The infant may be of previously unexceptionable history, except that the parents may be the subjects of disorders of the nervous system, of nervous temperament, have over-tasked brains, have been phthisical, or are intemperate. These convulsions now and then leave the sufferer impaired in mental power, and affected with spastic rigidity, undistinguishable from that which succeeds asphyxia neonatorum. It is scarcely necessary to add to the previous remarks on spasmodic and paralytic contractions that convulsions and other cerebro-spinal morbid states of childhood may be followed by spastic contraction, or paralysis of single muscles or sets of associated muscles.

Treatment. The indications for either the operative or mechanical treatment of these different forms of spastic and paralytic contractions, and the mode of conducting the treatment, are the same as those laid down in speaking of congenital club-foot (p. 567), modified by the nature of the cause of contraction. In contradistinction to congenital contractions, we may remark, that in contractions occurring during teething, the occurrence of structural shortening may generally be prevented by timely-applied manipulations, frictions, mechanical support to paralysed parts, or assistance to the antagonists in the case of spastic affections. It should be remembered as a reason for avoiding unnecessary tenotomy, that the contracted muscle is often the healthier one, and that in the case of a spasmodically affected muscle, tenotomy does not "cure" the spasm. It is often only temporarily beneficial, and sometimes transfers the preponderance to another set of muscles, merely substituting one evil for another. In severe general spastic contraction, the Surgeon has carefully to balance the good and evil, one against the other.

Flat-foot, or spurious Valgus.

This common deformity presents externally many of the characters of congenital valgus, and of the acquired valgus which results from paralysis of the anterior tibial muscle. But the resemblance is only superficial. The person treads unduly on the inner margin of the foot, the toes are turned outwardly, and the arch of the foot is diminished, or, in severe cases, may be obliterated; hence the term flat-foot. True valgus springs from congenital contraction of the peronei muscles; spastic non-congenital valgus from spasm of the peronei; paralytic valgus from partial or total paralysis of the anterior tibial; sometimes combined with paralysis of the posterior tibial, causing contraction of the peronei owing to the want of antagonists; but spurious valgus or flat-foot is due to general want of tone in the fibrous structures of the body,—displayed in the yielding of one of the parts of the frame most exposed to strain, the plantar muscles and ligaments; hence sinking of the arch, eversion of the toes, and secondary contraction of the peronei. After a time the displacement of the tarsal bones, connected with the sinking of the arch, leads to painful or difficult locomotion and limitation of the movement of the ankle-joint. Finally, the tarsus may be said to be convex inferiorly, concave superiorly, the anterior part of the foot being then drawn up by the conjoint action of the anterior tibial and the extensors of the toes, and the heel held tensely upwards by the muscles of the calf. Even in moderate cases contraction of the peronei is distinctly felt; in severe cases shortening of the remaining muscles above enumerated is also evident. In the worst cases scarcely any mobility of the ankle-joint remains. A slight degree of flat-foot is common in girls, especially amongst those of fine organisation in the upper and middle classes of society, less frequent in boys; and is curable amongst them by considerably reducing the amount of standing and walking exercise, by substituting horse-exercise where practicable, by avoiding fast walking in the company of adults, by early hours, by avoiding competitive over-study, by generous living, fresh air, tonics, attention to the state of the primæ viæ, embrocations, and manipulations directed to the promotion of inversion of the foot and prevention of the threatened contraction. In greater relaxation of the parts about the inner ankle, actual confinement to a couch, and carriage exercise for a month or five weeks, or that time spent on the sands or beach at the sea-side, will lay the foundation for cure. Laced boots, supported at the sides with stiff leather or thin steel busks, are of great assistance in walking. An elastic horse-hair, india-rubber, or felt pad beneath the inner margin of the foot tends to support the arch. Iron and cork, often employed for this purpose, are harsh and inefficient. We must utterly condemn a practice often resorted to in contempt of the pathology of the affection—that of severing the peronei and tendo Achillis in such cases. The recovery of patients from moderate flat-foot when this operation has been performed, is due mainly to the absolute repose of the limb with which the operation is followed, and to the mechanical measures concurrently employed. But in a few rare cases in private practice, and in those of boys who have stood prematurely behind a counter twelve or fourteen hours daily, and amongst the lower classes in public institutions who have suffered from premature labour, the deformity has existed so great a length of time that the contracted muscles have become shortened and rigid, rendering tenotomy, by its promptness and certainty of action, a necessary adjunct to the mechanical treatment.

Flat-foot often exists for several years without attaining even an intermediate grade of severity, when all at once a particularly long walk, a leap, or initiation into a standing occupation, becomes the starting-point of a considerable and rapid aggravation. Sometimes evidence of chronic inflammation of the calcaneo-scaphoid ligament, or other plantar structures, or a painfully stretched condition of the plantar nerve, exists. This last symptom is recognised by the exquisite, unbearable, electric-like, painful, tearing sensation described by the patient when he takes a long stride, or stands on the affected leg alone. We should not be induced to operate on flat-foot even on account of its long duration, or of palpable shortening of the tendons before enumerated, since even rigid contraction of muscles, healthy as to their innervation, will yield in a few weeks to judicious frictions, manipulations, disuse of the part (required in this deformity owing to its special exposure to aggravation by walking), and mechanical treatment. As an argument in favour of severing the Achilles and other tendons in slight cases, we have heard the question put, "What harm does the section do?" Now, although the tendo Achillis is very tolerant of the ever-ready operator's scalpel, it cannot be pretended that an unnecessary operation is a benefit. As, in extremely severe cases, the act of walking, after replacement of the tarsal bones, tends to bear down again the tarsal arch, the aid of mechanical appliances is subsequently needed for several months, or even sometimes for two or three years. Relief is much more readily obtainable in the child than in the adult. The apparatus available in these cases is the same as that used for varus, but with the action of the springs, screws, or lever reversed.

Subcutaneous division of the peroneus longus and brevis is effected in a manner similar to the operation of severing the tendo Achillis. The patient should lie over on the opposite side, an assistant holding the foot inwardly, so as to maintain extra tension of the parts. The tenotome should be introduced in front of the tendons, the section proceeding from before backwards.

Contractions of the Upper Extremity from Spasm and Paralysis.

The principles which should direct the application of tenotomy to spasmodic and paralytic contractions of the upper extremity are those which are applicable to other parts of the body, except in so far as the functions of the individual muscles of the upper extremity, especially those of the wrist and fingers, are more delicate, varied, and complex than, for example, are those of the corresponding parts of the lower extremity. We should be prepared to expect that a surgical proceeding which aims at intercalating a piece of new tendon, with the object of reducing the range of action, and therefore the power of a rebellious spastic muscle, or for the purpose of thereby weakening a healthy muscle so as to favour a partially paralysed antagonist to recover its activity, would be less successful than in the lower extremity, the actions and movements in which are comparatively simple. The acquirement of the power of progression, even if it be incomplete, amply compensates for the sacrifices the patient makes; in bad cases he is satisfied with the possession of a limited flexion and extension of the hip, knee, and ankle, and can be aided by mechanical appliances. But in the case of the wrist and fingers the individual derives little benefit from these simple movements, and he cannot be materially assisted by any complicated mechanism hitherto invented. We have divided the biceps at the bend of the elbow, the rigid, well-defined pronator radii teres at its muscular portion, the tendons of the flexor carpi radialis and ulnaris where most prominent close to the wrist, and have found the resulting benefit proportioned to the attention subsequently bestowed upon manipulations, passive exercises, and painstaking education of the enfeebled non-contracted extensors. Except in cases of many years' duration, in which the retracted muscles were reduced to inextensible fibrous bands, it has seemed that as much ultimate benefit was obtained by manipulations and exercises as by the employment of an operation, and at no greater expenditure of time. The prognosis must be based on the amount of improvement that may be expected in the affected portion of the nervous centres. As an encouragement to treatment, the Surgeon should remember that cases occur in which the disorder of the nervous system and nerves has ceased, and that he has to deal only with consequences. This observation applies also to many congenital contractions.

Deformity from Disease of the Palmar Fascia.

A not uncommon contraction in the upper extremity consists in a permanently flexed condition of one or more fingers, with visible and palpable thickening and hypertrophy of the fascia investing the palmar surface of the first phalanx of the affected finger and of the neighbouring portion of the palmar fascia. Sometimes the whole of the fingers and thumb are implicated, the palm itself is contracted, and the use of the member as a prehensile, and even as a tactile, organ almost destroyed. The ring and little fingers, the middle finger, index, and thumb, are usually affected in frequency and degree in the order in which we have placed them. The articulations are commonly unaffected, although occasionally that of the first phalanx with the second phalanx, or this with the third, has exhibited slight arthritic enlargement. On endeavouring to straighten the fingers, the Surgeon feels that a general resistance is offered by the tissues of the entire palmar surface of the hand and fingers, and especially by the indurated palmar fascia itself. Any existing tension of the flexor tendons cannot be felt along the fingers, but in the palm, particularly in the upper part, above the edge of the most indurated part of the palmar fascia, one or more tendons prominent and tense may be felt. This deformity is usually attributed to injury, often to a trifling wound, to irritation by the use of a whip in driving, of a walking-stick, or mechanical tool. These mechanical causes, or local irritants, if really operative, can be regarded only as occasional determining or exciting causes. The essential or primary cause is a constitutional one, allied to the gouty or rheumatic diathesis. We may not venture, however, to assert that the constitutional cause is identical with that of gout or rheumatism, as the persons affected have appeared singularly free from other manifestations of those affections. The disease of the palmar fascia, unlike gout or rheumatism, is painless. Many patients affected with considerably contracted palmar fascia in both hands present similar induration of the corresponding fascia of the soles; a sufficient proof that the complaint is essentially independent of the mechanical causes assigned for it,[1]—unless, indeed, we assume that the act of walking by stretching the sole can act upon the plantar fascia after the manner of a mechanical irritant. The symmetrical character of the affection, the precise resemblance of one case with another, the occasional existence of hereditary gout in the family, the frequent occurrence of the same deformity in father and son for several generations (four), as well as the above facts, confirm the opinion of its constitutional origin. We have never witnessed this complaint in the female. Those who have freely indulged in strong wines and spirits, or beer, are the frequent subjects of it.

We regard it, then, as a painless chronic induration of the fascia, leading to compulsory, gradually-increasing disuse of the fingers and hand. Through this disease the flexor muscles and tendons, which are probably free from the original affection, assert their preponderance over the equally idle extensors, and become gradually affected with secondary shortening.

Treatment. Even in tolerably advanced cases, frictions, manipulations twice or oftener daily, the application of a screw-adjustment splint, or straight splints of wood, tin, or gutta-percha, will, if suitably and perseveringly used, reduce the contraction and deformity. But at the advanced age at which many patients present themselves for relief, the employment of mechanical apparatus encounters many difficulties. In rigid unyielding cases of long duration, tenotomy is remarkably efficacious. We cannot by its means alter the constitutional state, or directly remove the induration of the fascia; but we are enabled to remove by tenotomy the secondary tendinous contraction, to take the case entirely out of the influence of the patient's will, as far as the contracted muscles are concerned, and obtain a starting-point for further benefit by mechanical treatment. A puncture half a line in width suffices for the passage of a firm tenotome beneath the tendon in the palm. The tendon is thus divided from below upwards. No fumbling or unnecessary handling of the part after the operation, by which means air or blood might be disseminated amongst the palmar tissues, is permissible. The operation, like most subcutaneous operations, is bloodless. We have invariably seen the puncture heal within forty-eight hours. Considerable yielding of the contracted finger, the tendon of which has been severed, is at once perceived. Manipulations and mechanical treatment complete the cure. We have frequently thus effected entire restoration of the hand and fingers. It is remarkable that the indurated fascia softens, and the hard ridges and corresponding furrows in the fascia disappear, under this treatment. It is obvious that the afflux of blood to the part excited and maintained by the frequent manipulations, frictions, and bandages, alters the nutrition of the part, and removes the previous morbid deposit. It is also probable that care as to diet and wine, whilst under the observation of the Surgeon, assists this process of recovery. The causes being constitutional, and the attention of the patient being liable to slacken after a lengthened recovered use of the member, the complaint occasionally returns. We have re-operated on a patient thrice in eleven years ; the individual expressing himself amply compensated for the operation by nearly as many years' good use of the part. This operation is a valuable illustration of the success of subcutaneous tenotomy compared with Dupuytren's painful operation, even when performed by so able a Surgeon as the late Sir A. Cooper. We have had under observation two cases in which, by means of a large crucial incision of the palm, the indurated fascia had been dissected out and removed. The operation had no better result than that of causing a large contracted cicatrix, more rigid than the former state of things, and quite irremediable.

Wry-Neck.

Torticollis, or wry-neck, is a not very uncommon distortion of the head and neck, originating, like club-foot, from a variety of influences ; some acting through the muscles—congenital, spasmodic, paralytic ; others acting through the ligaments and bones —rheumatic and strumous. Occasionally the point of departure of a case is strumous affection of the lymphatic glands, and sometimes loss of textures from sloughing after burns or a gun-shot wound.

Congenital wry-neck. This is the most common form of wry-neck. It is perceived a few months or more after birth, and when suffered to proceed unchecked gradually increases during childhood, adolescence, and adult life, until it attains the proportions of a formidable deformity. Many cases of wry-neck, reputed to be congenital, have appeared to originate from accidents at birth, in consequence of breech presentation, turning, &c. We will describe an adult case, in which the right sterno-cleido-mastoideus is the head and front of the offending, for it is probable that other muscles are always either primarily or secondarily involved. The entire head leans to the right side and slightly forwards, the right side of the neck is somewhat hollowed, whilst the left side is unnaturally convex, and the patient not unfrequently complains of pain in this situation. These changes in the form of the neck are more pronounced at the upper part, *i.e.* opposite to the base of the cranium, that being the region most influenced by the contracted muscles. The chin is drawn to one side, and approaches the left shoulder; the right ear is approximated to the sternal extremity of the clavicle. The sterno-cleido-mastoideus of the affected side (right) has lost its symmetry, being reduced to a comparatively narrow, hard, tight cord, three inches in length, the muscle of the opposite side measuring five and a half inches. This prominent cord is double below, representing the double origin of the muscle. In the adult a marked upward bend of the clavicle is seen where the clavicular portion of the contracted muscle arises, induced by the constant abnormal traction to which the bone has been subjected, and the inferior portion of the muscle itself appears of cartilaginous or osseous hardness, and is lost in a large bony process on the protuberant clavicle. If we examine the neck and shoulders posteriorly, we observe that the cervical vertebræ have yielded to the dragging of the contracted muscle; this part of the vertebral column presenting a convexity on the left side, which is compensated for by a curvature in the opposite direction lower down. The right side of the head, neck, and right shoulder, are considerably smaller than the parts on the opposite side; the right shoulder and scapula being unduly raised. A singular effect upon the face results from this difference in size, combined with the impediment to the function, which the abnormal position of the head involves. In the adult case from which we describe, so great is the difference in size between the two sides of the face, that on the right side the external canthus of the eye is distant from the external angle of the mouth three inches, whilst on the left the distance amounts to three and a half inches. The inclination of the head to the right causes the right eye to be habitually situated on a still lower plane than would be the case if atrophy of the affected side were alone operative. The atrophy and the slight bending forwards of the head interfere with the direction and use of the right eye, and cause a peculiar expression of archness and sense of difficulty and suffering. These features of the deformity are, as already mentioned, proportionally less marked in early life.

The principal muscles on the front of the neck are probably involved, the trapezius and scaleni, as well as the sterno-mastoid. In this and other respects congenital wry-neck offers much analogy to congenital club-foot. The principal contraction affects in both cases muscles which pass over more than one articulation, the sterno-cleido-mastoid in one case, the gastrocnemius in the other;

hence in the neck the mischief of morbid contraction may effect a higher degree of deformity than if the contracted muscle influenced one articulation only; in the leg the contracted gastrocnemius does not always limit its evil influence to the foot, but contracts and distorts the knee. In both wry-neck and club-foot other muscles participate in the deformity; but the range of influence of these being less, or being counteracted by antagonist powers, their contraction is not so apparent. It is an interesting question of physiological pathology, whether there is any thing special in the anatomy and function of the sterno-mastoid and gastrocnemius, that they should obtain the distinction of entering into so large a proportion of cases of congenital and acquired deformity. The gastrocnemius, by its great development, its greater nervous supply, and its relation to the upright stature and locomotion of man, is certainly entitled to a peculiar and elevated rank in comparative and human myology; so, when we reflect upon the size of the sterno-cleido-mastoid, its relation to the large vessels of the head and neck, its deriving its nerve-power mainly from a special nerve (spinal accessory), and remember the influence of this muscle upon the act of respiration, we cannot deny it a preëminent function amongst its neighbouring muscles.

We have elsewhere shown* that not unfrequently wry-neck appears to result from straining or injury to the neck during difficult labour, from traction of the head by instruments. It is superfluous, after what we have said of the causes of congenital club-foot, p. 565, to refute in detail the theory which would attribute wry-neck, like club-foot, to accidental uterine or pelvic pressure. Congenital wry-neck clearly originates from causes acting through the nervous system.

Treatment. It is probable that, as with slight congenital club-foot, so slight cases of congenital wry-neck, if early detected, are removable by frictions, manipulations, and subsequent education; but all the cases we have seen, varying in age from four to forty-five years, have exhibited so much contraction and proportional secondary deformity, that we have in no case delayed division of the sterno-cleido-mastoid. It has always seemed justifiable to gain at once, by means of this operation, a large measure of relief; thus affording an encouraging starting-point for the after labours of the attendant in overcoming the shortening of the integuments, platysma fasciæ, associated muscles, ligaments on the hollow side of the neck, and gradually to act upon the altered relation of the articular facets of the inclined vertebræ.

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* *Trans. Obstet. Soc.* 1862.

Division of the sterno-cleido-mastoideus is performed subcutaneously, upon the principles practised by Stromeyer in division of the tendo Achillis, viz. effecting the division by the smallest possible wound in the integuments and the narrowest tract through the subcutaneous tissues, and avoiding any external bleeding or extravasation of blood into the areolar tissue, or admission of air into it. Neglect of these precautions would be calculated to excite suppuration and prevent immediate healing of the puncture, and delay untowardly the employment of the necessary after-treatment, until, perhaps, the severed tendon might be reunited and implicated in the surrounding adhesions, the case thus becoming less amenable to the necessary mechanical treatment than before operation. The spot chosen for the operation should be that at which the tendon springs rigidly across the important subjacent organs, and where consequently most space is afforded for introduction of the tenotome beneath the tendon without risk to those organs. In wry-neck this spot will be found from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch above the clavicle. It is also more easy to sever the muscle entirely by keeping at this distance from the bone. In some cases we have found the sternal portion only developed and rigidly contracted; a few weak fibres attached to the clavicle having, before the knife reached them, yielded to the tension maintained by the assistant. In cases in which the clavicular origin of the muscle is broad, it is safer to divide the sternal and clavicular portions each by a separate puncture, rather than pass the knife by one puncture made in front of the neck as far back as may be necessary to reach the whole of the clavicular portion. This precaution is justified by the anterior and posterior edges of the muscle not being on a plane surface; for although the fasciæ of the lower part of the neck may usually bind down sufficiently the vessels and nerves, and so keep them out of danger, it is well to remember the liability of meeting with abnormal distribution. The complete division is accompanied by a very sensible crack, and the head at once assumes a much improved condition. We have measured immediately after operation, and have found the difference in length between the affected and sound muscle reduced more than one-half. The puncture should at once be covered with a compress of lint, and a common bandage be applied. We have found no harm result in the case of the sterno-cleido-mastoid in allowing the ends to separate as far as they were inclined. In young and flexible subjects, we have found adhesive plaster and a common roller-bandage an amply sufficient mechanical contrivance to aid in rectification of the head. Apply a long strip of adhesive plaster around the forehead and occiput, its maintenance in position being better secured by a bandage passed over the vertex and beneath the chin, the two being pinned together where the one passes over the other, above the ears. Next attach around the waist a broader band of adhesive plaster, not so tight as to interfere with the movements of the ribs; over this a turn or two of calico roller-bandage; the two should be fastened together by a stitch here and there. The Surgeon has now two circular bandages, the one around the forehead, the other around the waist, which are not likely to slip if properly applied. He should then sew a strip of ribbon to the head bandage directly above the ear of the unaffected side, and carry it diagonally across the trunk to the opposite side of the waist bandage, and there pin it. By this means the left mastoid process (we are speaking of wry-neck caused by contraction of the right sterno-mastoid) will be drawn towards the right sterno-clavicular articulation, the original wry-neck be removed, and the chin brought to the median line, or in young and flexible subjects even across it, towards the affected side, constituting a temporary wry-neck in the opposite direction. The circular or ovoid form of the cranium renders it difficult to act upon it for any length of time by any apparatus hitherto invented. The apparatus will shift its direction, or rather the head will partially disengage itself. Hence even a greater necessity for manipulations exists in wry-neck than in other deformities. No apparatus effects so beneficial and lasting an impression upon the distortion as the hands of the Surgeon or attendant. Whilst one holds down the shoulders, the other, standing behind the patient seated, should apply firmly his flat hands to the sides of the head, and direct the chin, vertex, or occiput in the required directions. Such manipulations need to be done with due caution and technical skill. It is not necessary to cause pain in order to produce much good. They should be employed three times a day. The plaster and roller-bandage which we have described is most convenient in reference to these manipulations. It may be unpinned in a moment, and as quickly readjusted. We have cured many cases by the means here enumerated, in periods varying from one to three months, and have never had occasion to repeat the operation. Manipulations as a precaution against relapse may be longer resorted to; but the patient's voluntary efforts are more employed for obvious reasons, and are more successful, than in some other congenital deformities. An apparatus similar to that described p. 597, for ectification of the position of the head in deformity from vertebral isease, may be employed in cases of adult congenital wry-neck uring some portion of every twenty-four hours. It readily effects e-position of the lateral or forward inclination of the head, but is owerless to affect the abnormal rotation of the head round the orizontal axis.

Acquired or non-congenital spasmodic wry-neck. We have seen everal cases of active, violent spasm of the sterno-mastoid in unmarried females of middle and advanced age, causing severe wry-eck. The spasm is commonly jerking, irregular, convulsive, never easing entirely whilst the patient is awake. The disorder has usually commenced about the age of thirty in subjects not obviously hysterical, persons of excellent intellectual and social character, whose families have seemed prone to other cerebro-spinal affections. We have watched several of these cases for many years. The spasm and deformity have in every case gradually increased, often rendering the patient's existence distressing through incessant motion of he head, disturbance of sleep, and pain in the neck, apparently due o strain of ligaments and nerve-disturbance, and sometimes accompanied with pain referred to the upper part of the spinal cord itself, as in some cases of "spinal irritation." Now and then the spasm s so considérable that the ear of the affected side is drawn down by a series of jerks so as almost to touch the clavicle. The patient's voluntary efforts to arrest the pulling down of the head appear to ncrease the disorder. Such patients, being compelled to endeavour to steady the head with one hand, seldom appear in public. We have employed mineral and vegetable tonics, galvanism, and electricity, with only temporary benefit. However, as might be expected, generous diet, hygiene, and freedom from mental disturbance, alleviate the symptoms. Complete relief is afforded by subcutaneous tenotomy of the affected sterno-mastoid; but even this measure is only useful for a time; for after two or three months, or as soon as reunion of the severed part is complete, the spasmodic shortening and jerking return. Stromeyer had a patient who submitted to two repetitions of tenotomy for the sake of the temporary relief afforded by the operation. The author once operated on an elderly female who had suffered from spasmodic wry-neck upwards of twenty-five years. She had been unable for many years to sleep in the recumbent position, but dosed in a high-backed nurse's chair, provided with side-supports for the head. For a few nights after the operation she slept soundly in bed. The malady, however, returned, and she ultimately sank exhausted, want of sleep appearing to be a principal cause of the fatal result. The operation on the sterno-mastoid is insufficient to affect the remaining muscles, which are sometimes involved.

Paralytic wry-neck is rare; we have not seen more than three cases. The head is drawn to one side by the healthy muscle, which is deprived of its antagonist. Sometimes a case occurs in which, in consequence of difficult birth, the head falls helplessly to one side more than is common to new-born infants, probably from mechanical injury to some of the structures in the neck. Such cases resemble wry-neck from paralysis, but differ by the history, and by the evil being less confined to the sterno-mastoid. These weak necks from injury at birth, as far as we have had the opportunity of watching, have gradually recovered. In paralytic wry-neck, when the stage for ordinary treatment of the partial paralysis has passed, we can do no more than support the head by the padded-leather or steel-spring cravat. Except when the unparalysed sterno-mastoid is structurally degenerated or very rigidly contracted, and is insusceptible of elongation by manipulations or mechanical treatment, it would be as irrational to employ tenotomy as it is in a case of contracted gastrocnemius which has simply lost its antagonist, and which can be relieved by a suitable mechanical support without operation.

Wry-neck, from disease of the cervical vertebræ, is caused by strumous, and sometimes by rheumatico-strumous disease of one or more cervical vertebræ, from which the head inclines to the affected side. The chin is directed to one side, although this feature is less marked than the sideward falling of the head. In bulging of the opposite side of the neck, and in general appearance, these cases much resemble congenital wry-neck, but are distinguished from it by their history, the pain on motion, the aspect of strumous or constitutional disorder, by hectic, by the instinctive aversion of the patient to the Surgeon's handling of the head, and concomitant glandular or other forms of strumous disorder in the one case, or rheumatic affection in the other. The pathological changes common to disease of the vertebræ in each region, and its peculiar dangers when situated in the neck, are described in a subsequent essay. Great caution is necessary in handling these cases, lest the disintegrating bones give way suddenly to the pressure, or the reparative process which may be going on be interrupted. Much benefit to the disease itself, and gradual improvement in the position of the head and neck, may be effected by a well-adjusted supporting and rectifying apparatus, as well as by the recognised medicinal, dietetic, and hygienic treatment of the constitutional malady. The most efficient apparatus consists of a padded metal plate, secured by straps beneath the axilla and around the chest upon the shoulder of the side to which the head inclines. From this shoulder-pad an iron upright piece extends upwards, by the side of the neck, to the parietal region. The lower end of this upright is attached to, and moves upon, the shoulder-plate by means of an endless ratchet screw; the upper end is connected with a pad intended to be adjusted and pressed against the parietal region. In adults and very severe cases, this apparatus may be attached to a common spinal support for the chest and pelvis, for the sake of greater fixity and more powerful leverage. Sometimes an iron stem is required to extend upwards on one or both sides of the head, with connecting straps to be applied beneath the chin and occiput, so as to receive the weight of the head. Much opportunity for the ingenuity of the instrument-makers is afforded by these cases. In the present day we do not find it necessary to employ the cumbrous and unsightly machines, consisting of an iron scaffold and gibbet for suspension of the head, to which Surgeons resorted as lately as the commencement of the present century.

Knock-knee, *In-knee* (*Genu valgum*).

This frequent deformity, of which instances are met with at all ages, consists of an inward yielding of the knee-joint, in consequence of weakness of the ligaments and muscles which respectively connect or surround the articular extremities of the femur and tibia. Its causes are identical with those which produce in-ankle, or flat-foot (talipes valgus spurius), p. 585.

Abnormal states of general nutrition in children and adolescents, dependent upon insufficiency or improper quality of food, are a common predisposing cause of this deformity. Sometimes it appears probable that the constitutional weakness, or laxity of tissue, has been engendered less by unsuitable supply or quality of food than by imperfect assimilation, owing to deficient aëration of the blood, as in children reared in confined dwellings, both in town and country. In many cases, the abnormal nutrition proceeds to the length of developing an unmistakable rachitic condition, known by the co-existence of the peculiar curvatures of bones which characterise that disease. Our observation of the numerous gradations of knock-knee met with in young children, varying in outward appearance from the most flourishing health to the most miserable, wasted, and dwarfed extreme rickets, has convinced us that even in the slighter forms of knock-knee a degree of impaired assimilation of food and an abnormal state of blood, similar to that present in rachitis, exists. In these slighter cases of knock-knee, traces of rachitis will be found in prominence and deformity of the cartilages of the ribs, flattening of the sides of the chest, and sinking-in of the sternum. One or more severe attacks of bronchitis, or broncho-pneumonia, have frequently been with justice regarded by the friends as the forerunner of the "weakness of the limbs." In many instances the earliest link in the chain of causation has been an error in the infant's diet; namely, the substitution, for an insufficient supply of breast-milk, of farinacea boiled in *water*, with the addition of little, if any, cow's milk. Sometimes we may ascend a degree higher, and discover an hereditary pathogenetical influence. We have several times observed knock-knee in small, delicate, prematurely-born children; the limbs, as a consequence of general weakness, having yielded to the superincumbent weight of the trunk. Such cases should not be confounded with the *inverted* flexed and contracted knees which occur in children who, in consequence of premature birth, have suffered from asphyxia neonatorum (p. 581). Knock-knee often shows itself before the child has attempted to walk, this act being occasionally delayed by it as much as three or four years. When the deformity attains a certain grade, it may increase rapidly from the effects of walking, or it may increase so gradually as not to excite the parent's anxiety, until at length, about the age of seven, ten, or twelve years, the child is again "thrown off the feet," and becomes incapable of walking without crutches or other support. The deformity often takes place in tall, rapidly-growing lads from the age of twelve to eighteen, who may have exhibited no previous tendency to it. Undue exercise, and fatigue in standing and walking, with late hours and the poisoned atmosphere of ill-ventilated places of business and dormitories, appear in such individuals to have contributed to the complaint. Undue strain upon a sound limb, in consequence of some other defect in the opposite limb throwing increased exertion and weight upon it, may produce this deformity.

Treatment of knock-knee. We have heard it maintained, that, as a rule, children recover spontaneously from this affection. In a small proportion of cases, spontaneous recovery of good power of walking takes place; but an examination of such instances has shown us evident traces of the affection in the persistent enlargement of the internal condyles, with inability to take long walks on several successive days, without weakness and pain on the inside of the knee. Slight cases will recover under improved dietetic and hygienic influences, with the aid of suitable manipulations, and the discontinuance of premature teaching the child to walk. Sometimes we can, in addition, advantageously recommend the recumbent posture during certain short periods of the day, and combine with this repose the placing a soft pad between the condyles, the limbs being extended, and the ankles being gently drawn towards each other by means of a soft bandage, strap, or other ligature. In carrying out this plan, we require to watch that the knees be not too fully extended, *i. e.* bent backwards beyond the horizontal line of the couch; a condition apt to ensue as another consequence of undue laxity of articular ligaments. In worse cases, more persistent mechanical means are requisite; simple padded wooden splints, a short one applied behind the knee to prevent flexion, and a long one reaching from the trochanter to the malleolus externus, not too tightly bandaged, may suffice. Modifications of such splints, constructed of metal or wood, articulated at the knee, furnished with a ratchet-screw to permit adjustment to the inward inclination of the knee, and secured by straps and buckles, may be found at most instrument-makers'. On the whole, even in moderately severe cases, but especially in aggravated cases, no apparatus is so efficient as a well-constructed iron to extend from the pelvis, on the outer side of the limb, sometimes on both sides of the limb, to the bottom of the shoe, the hip and ankle joints being left free, the knee *fixed* in a somewhat improved position; which may be further rectified from time to time, as the progress of the case demands, by means of the adjusting screw or straps. The Surgeon should see that the apparatus is constructed with due regard to the anatomico-pathological and the mechanical wants of the case. For example, irons, to be promptly effective, need to take suitable points of support against the upper part of the outside of the thigh and the lower part of the outside of the fibula.

Severe cases require the knee to be prevented from bending when standing, during a period varying from three to six months; then freedom of motion during a part of each day for a similar though variable period; and, lastly, perfect freedom yet a few months, before discontinuance of the support. The total average duration of treatment of bad cases in advanced childhood may occupy two years. Care should be taken to employ daily frictions and manipulations, so as to prevent the knee becoming stiff in an extended position. We were formerly accustomed, in severe in-knee of adolescents, to aid the mechanical treatment by previous section of the outer hamstring; but the observation of the length of time occupied in the treatment, notwithstanding the tenotomy, and indeed a conviction forced upon us that the operation did not appreciably shorten the treatment, has caused us for many years past to discontinue recourse to it. In adolescents the most severe cases will recover with the aid of manipulations, exercises, and mechanical apparatus, without confinement to the couch; but until a straight limb is obtained, recumbency, by removing the weight of the trunk, greatly accelerates recovery. We are bound emphatically to protest against the operation of removal of a wedge-shaped piece of bone from the upper part of the tibia, performed by M. Meyer for the cure of this deformity. It is a sufficient condemnation of this severe operation to remind the reader that knock-knee is not dependent upon curvature or deformity of the tibia, but upon a removable displacement of the relation of the articular extremities which enter into the knee-joint. Consequently, an operation of the kind performed away from the joint is at best a clumsy proceeding, and not without danger. Division of the external lateral ligaments, another operation recommended for knock-knee, is also unnecessary.

Ankylosis of the Knee and other Articulations.

The successful labours of orthopædic practitioners have contributed to improve the knowledge of the real condition of joints after the cessation of various forms and degrees of inflammation and degeneration. The erroneous notion, that long-continued repose of a joint alone sufficed to induce such alterations in its articular surfaces as to lead to bony union, and the remarkable rigidity and immobility which result from the agglutinated or contracted extra-articular structures—fasciæ, muscles, and ligaments—especially when dense, fibrous, deeply-extending cicatrices co-exist, favoured the supposition of the common prevalence of true bony, irremediable ankylosis. We now know that absolute bony union of articular surfaces is a comparative rarity, even in pathological cabinets.

For practical purposes we may divide the conditions in which joints contracted from disease are presented to the Surgeon, with a view to the restoration of form and motion, into three classes. 1st. Those in which the resistance to motion is furnished solely or mainly by the extra-articular tissues. 2d. Those in which, in addition, more or less considerable changes within the articulation have occurred, viz. transformation of the synovial surface, vascular adhesions, fibrous adhesions, erosion of cartilage or of bone, mineral or bony deposits. 3d. Absolute osseous ankylosis.

The first class of cases is common. We have met with numerous instances of knee and elbow-joint contraction, induced respectively by severe, deeply-extending burns, by phlegmonous erysipelas, by "swelled leg," in which the history of the case, the state of obvious contraction and adhesion of the extra-articular tissues, together with the absence of displacement or deformity of the articular extremities of the bones, left no doubt in our minds that the articular surfaces, notwithstanding the paucity of motion, or its entire absence, were free from organic change. In these cases, restoration of form, and often an almost complete recovery of spontaneous, *i. e.* voluntary, movement, may be effected without difficulty.

The second class of cases includes some which have had a similar origin to those of the first category, but in which the injury or inflammation has extended to the interior of the joint, or at least has involved the capsular ligament. In these cases, deep, retracted, indented cicatrices, and bands of indurated adventitious tissue, penetrating, it may be presumed, into the hollows and sinuosities of the ends of the bones, even if all happen to be exterior to the articulation, tell of exposure of the synovial membrane so near to the disease, that it is improbable that it will have escaped. These cases admit of rectification of position, and commonly some degree of voluntary motion follows, but not always until months or years after active orthopædic treatment has been discontinued. The bulk of the second class consists of cases resulting from strumous synovitis (?) and diseases of the articular extremities, rheumatic and gouty contractions, and distortions from accidental violence.

The strumous distortions of the knee usually present considerable mobility within a limited range, with much deformity and prominence of the internal condyle from subluxation and from wasting of the member above and below the articulation. They are usually straightened without difficulty, although much prominence of the condyles and subluxation will remain. Partial mobility is usually recovered.

The rheumatic cases which apply for orthopædic relief are principally of two kinds, those in which "chronic rheumatic arthritis" subsists, and those rarer instances of acute articular inflammation excited by exposure to cold during gonorrhœa, childbed, or an early stage of lactation. In the first kind, during tho comparatively early stage, much intra-articular fluid secretion and free mobility within a certain range remain. At a later stage, in proportion to tho development of gelatinous and vascular adhesions and mineral deposit, the movement becomes more limited. Before and subsequently to the appearance of Bonnet's work, *Thérapeutique des Maladies Articulaires*, we have been accustomed to attempt, by gentle manipulations and gentle but firm employment of mechanical contrivances, to restore these limbs to greater usefulness as regards movement and symmetry. We have succeeded in obtaining the latter, but not the former desideratum. In fact, as might be inferred from correct pathological knowledge, the benefit of orthopædic treatment is in the inverse proportion to the anatomical degeneration which the rheumatic joint has undergone.

In the second kind of rheumatic cases of partial ankylosis, those which have commenced with very acute affection of one joint, most often the knee, the loss of motion occurs rapidly, and is frequently complete. It seems, in these cases, that an acute destruction of the synovial surface, with rapid exudation of mortar-like plastic material, takes place, causing firm agglutination of the ends of the bones.

Tact in the examination will usually show that absolute immobility of the knee, from whatever cause the ankylosis has proceeded, does not exist. The Surgeon can with certainty determine that the joint is movable if an energetic effort to bend or straighten the limb produces a sharp pain through it. We may deduce some favourable conclusions as to the state of the joint if we find the patella movable. This bone may sometimes be moved upon its perpendicular axis when no motion is perceived upon the horizontal one, and when no flexion or extension of the knee can be effected by ordinary handling of the joint.

We make no other mention of stiffness of joints from common articular rheumatism, acute and chronic, than to observe, that as this affection usually leaves the synovial membrane intact, no deformity, as a rule, remains, the exception being in the ankle; here the weight of the body comes more mischievously into play than elsewhere, and sometimes gives rise to a rheumatic in-ankle or flat-foot.

Many rheumatic contractions, those which are the least amenable to treatment, belong to the peculiar form of the disease denominated "chronic rheumatic arthritis" by Adams of Dublin, the "rheumatoid arthritis" of Garrod.

As a rule, in reference to orthopædic treatment, a correct judgment of the condition of a joint contracted from disease may be formed from the history and the external appearance, aided by careful manual examination. In the hip, the diagnosis is sometimes more difficult, because the history communicated may be fallacious in consequence of the greater liability to errors in diagnosis during the first stage of disorder in and around this articulation. Thus we have seen hip-contractions in which the primary hip-affection had been originally sciatica, muscular and fascial rheumatism of the bulk of muscles of the hip and loin, one of the forms of rheumatism of the joint itself, "morbus coxæ," or the result of accident. To these causes of hip-contraction, which are not always diagnosed, we may add the peculiarly grave intra- and extra-articular exudation which occasionally occurs at the close of malignant scarlatina, and the less serious persistent drawing up of the thighs which occurs (without pyæmia) during a tedious confinement to bed from fevers and phlegmasiæ, especially in persons whose growth is not complete. We have also met with severe rigid hip-contraction, with pain and wasting, which had commenced during pregnancy from uterine influences; also after childbirth from puerperal disturbance; and in unimpregnated, as well as in unmarried women, even from great fæcal accumulation in the intestines. Whilst reminding the Surgeon of the various causes of persistent hip-contraction, we may complete the list by adding congenital contractions and luxations, paralytic and spasmodic contractures, some of these being hysterical, and some very grave affections, proceeding from disease of the brain or spinal cord, sometimes co-existing with angular spinal curvature. We have not enumerated these numerous causes of hip-contraction, as if they were so many pitfalls to the Surgeon; but in order that, knowing what may have produced a given contraction, the young Surgeon may be forearmed for diagnosis and successful treatment.

Treatment of partial and complete ankylosis. The several forms of contracted joints of the extremities above enumerated admit of three modes of treatment: 1st. Mechanical extension, including manipulations and shampooing. 2d. Tenotomy, succeeded by gentle gradual mechanical extension. 3d. Violent extension under the anæsthetic influence of chloroform, sometimes preceded by tenotomy.

The majority of joints affected with incomplete ankylosis, even the knee, elbow, or hip, still more the smaller articulations, and even after three or four years' duration of the contraction, admit of as full and prompt restoration by gradual, gentle employment of mechanical extension as by either of the remaining modes of treatment above indicated, with the advantage of the treatment being conducted without pain, suffering of any kind, or confinement to the house. In severe knee cases of many years' duration, subcutaneous division of the hamstring muscles may advantageously precede the mechanical treatment, the Surgeon bearing in mind that here, as in other distortions, success depends more upon the manner in which the mechanical treatment is conducted than upon operative interference. In a small proportion of cases, those in which apparent total immobility exists, or in which it is obvious that partial calcareous deposit has taken place, violent extension, with the aid of chloroform or ether, may be employed. We annex a few detailed observations on the mode of conducting each of these processes.

Mechanical Extension of partially Ankylosed Joints. Long experience in the use of mechanical apparatus shows how little actual apparent power is required to overcome the most rigid contractures of joints. The first condition of success is the correct adaptation of the appropriate apparatus to the size and natural movements of the part. It is of much importance also, that, when practicable, the apparatus should only limit the movement of the affected joint towards the contracted side, *i. e.* it should not immovably fix the part in every direction, but should leave some 'play' to the limb in the direction which it is wished the part should take. No curable ankylosis, free from bony union, can resist gradual gentle pressure; we only resort to tenotomy, in addition to mechanical extension, for the purpose of saving time. A little consideration will explain how apparently slight continued pressure can effect so great a result as the straightening of a knee contracted for twenty years from former articular disease or injury. The uninitiated Surgeon is accustomed to regard such a joint as 'nearly ankylosed;' perhaps he does not reflect that, if bony union have not taken place, the opposing structures are 'soft parts,' *i. e.* shortened muscles, ligaments, fasciæ, cutaneous textures, and cicatrices, all liable to yield to steady pressure. It is probable that as soon as this gentle pressure is applied, the contracted muscles, shortened merely from position and repose, *not being spasmodically affected*, resist elongation, but they speedily tire, and give up the unequal struggle; the non-muscular parts, however dense they may be, probably undergo some change of vascularity, some interstitial change in their nutrition as a consequence of the *gentle violence* they undergo, through which their mechanical power of resistance is diminished. An increase of temperature and of bulk of the part undergoing mechanical extension is usually perceived, which we believe to be due to increased flow of blood consequent upon the stimulus of the state of tension in which the resisting tissues are maintained. This augmented flow of blood is unaccompanied by inflammation or even by pain when the part is at rest. Such appears to be the process in the structures on the contracted side of the member. The treatment probably receives aid from the muscles on the uncontracted side. The direction of the distortion was originally determined by the stronger set of muscles, or by those most advantageously situated, having overpowered the weaker set. When the contracted muscles yield in their turn to the mechanical instrument, the muscles situated on the uncontracted side tend to recover their lost sphere of action, and assist replacement.

The knee-joint, being a simple hinge, while the thigh and leg each offers a great length of leverage, is advantageously formed for successful orthopædic treatment by mechanical extension; and consequently we meet with no partially ankylosed knee which cannot be straightened and rendered fit for use without the aid of tenotomy or chloroform in a period varying from one to three months.

The anatomical relations of the hip-joint render it less favourable for orthopædic treatment than any of the ginglymoid articulations. At the hip, the shortness of the lever afforded by the small depth of the pelvis, and the difficulty of fixing the pelvis, explains why, when power is applied to the thigh with the view of extending the abnormally flexed or contracted hip, the lower part of the vertebral column, back, and loins, yield anteriorly, causing an extreme hollow in the loins (lordosis). In fact a small part only of the power employed is effective on the contracted hip-joint, the greater part being expended in dragging forwards the lowest dorsal and the lumbar vertebræ. We may mention, in illustration of the comparative difficulty of straightening the hip, that in an instance of uniform fibrous and vascular membranous adhesion of the head of the femur within the acetabulum after death, the partially ankylosed pelvis and thigh having been removed from the body, we were unable to extend the hip by any power we could exert with our hands, until the capsular ligament and some of the adhesions within the acetabulum had been severed with the knife. The same kind of adhesions in a knee would have yielded to the power fruitlessly employed at the hip.

Great ingenuity has been displayed in the manufacture of the apparatus. Occasionally considerable demands upon the skill of the mechanist are required. The continued attention of orthopædic practitioners who, during the last five-and-twenty years, have trodden in the footsteps of Scarpa and Stromeyer, bringing pathological and anatomical knowledge, with experience, to the aid of the instrument-maker, has revolutionised, simplified, and thus far perfected orthopædic apparatus. As a general rule, elaborate instruments should be avoided. They are often strictly articles of luxury, not obtainable for the treatment of the majority of cases that present themselves in private, and especially in public, practice. We may affirm that when *nothing* can be effected for the relief of a deformity without a complicated instrument, very little can be effected with its assistance. Yet in numerous instances, as in congenital club-foot of adolescents, in considerable knee-contractions, and subluxation, the necessity of well fixing one part whilst another is acted upon, or the complicated character of the deformity itself, entails corresponding need of an elaborate contrivance.

Different mechanical forces are employed—the lever, the screw, and the spring; the last two often resolvable into the lever, screws and springs being employed to modify the action of the lever. The discussion of the relative advantage of the different modes of applying these forces would lead us away from our immediate object.

It should be borne in mind during the employment of these forces in orthopædic apparatus, and especially in the use of the screw, that it is available less as a means of abruptly forcing the deformed parts into their natural position than as an adjusting contrivance. In any case in which the screw is *forcibly* employed, unless for a very brief period, excoriation, sloughing, or intolerable pain, will inevitably result. In some *patient* individuals, vesication, and even superficial sloughs, may be induced over projecting bones without complaint of pain—an urgent reason for anxious examination of a part subjected to pressure, especially by the inexperienced orthopædist. Large sloughs are more than inexcusable.

Every apparatus should be padded, so as to avoid pressure upon prominent points of the bone, and adapted to each individual case. The orthopædic apparatus, like that for a fractured limb, should compress the part in its circumference as little as possible, and never tightly encircle it. It should act gradually, *in proportion as the deformity itself changes its form.* We have endeavoured in our previous remarks to show, that if a contracted member,* a knee for example, is evenly secured in a suitable apparatus, accurately adapted to the degree of bending of the joint, the processes which ensue in the joint when a moderate tension is imparted soon favour the moving of the joint in the direction contrary to that which it may have long maintained. A contracted knee resting upon its posterior aspect in an apparatus, tends by its own weight to regain a straighter position.

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* The greater number of contracted joints, when not affected with bony ankylosis, if left to themselves, may be regarded as contracting joints; for the contracting process is ever progressing until it attains the maximum.

At the outset, the Surgeon should be content simply to apply the instrument to the deformity, and not to apply the deformity to the instrument, as is too often attempted by novices in orthopædic practice. In this gentle manner of proceeding, the first difficulty in the treatment of every case of deformity is overcome,—the patient suffers nothing from the attempt to straighten the part; the simple inconvenience of wearing an apparatus, the irksomeness attendant upon necessary confinement of the affected part in an unfamiliar instrument, is his only trouble, and one which is speedily, in a day or two, overcome. Having once applied a well-fitting instrument, the screws or straps by which it is adjusted to the now improving member require to be advanced or tightened as opportunity offers. An impatient advance of the pressure will, by production of pain, and necessity for relaxation of the instrument, occasion loss of time. The principle of action in the progress of mechanical treatment should be that of never advancing too rapidly, so as to risk the necessity of receding. By gentle means, and uniform steady advance, the patient's confidence, so essential to prompt recovery, remains undiminished. By subjecting the member to no greater pressure than can be easily borne, no temptation to loosening the apparatus is afforded to the timid, and no risk is incurred of occasioning excoriation or inflammation in individuals possessing greater endurance, or in young children, whose cries may be attributed to other causes. In this manner, in suitable cases, the opposition offered to restoration by fasciæ, tendons, ligaments, and ill direction of articular surfaces, apparently irresistible, may, with the further aid of manipulations, be removed.

In the choice of mechanical apparatus the Surgeon should also be guided by that principle which actuates him in the selection of therapeutic agents in any internal or external disease, viz. the use of that means the action of which he best understands, or in the use of which he has had most experience. A common splint, properly applied, will effect more benefit than an instrument of greater pretension indifferently managed.

From all these considerations, it is apparent that much harm will result, in the great majority of deformities, from the habit sometimes pursued of keeping a deformed part many weeks in succession in an apparatus without the removal so necessary for the purpose of cleanliness, manipulations, and readjustment. Among the evil consequences of too long retention of instruments, often combined with unsuspected excessive pressure, the author has witnessed the production of an opposite kind of deformity, as the conversion of varus into valgus, and a degree of rigidity of the part, which has required weeks of painful manipulations and stretchings before the natural movements have been possible,—sometimes, indeed, restoration of motion of an articulation has been rendered impossible.

The slighter the deformity, the more necessary is frequent removal of the apparatus, because by removal and appropriate manipulations we insure retention of mobility. In severe cases, in which we expect only to effect straightening, and do not anticipate restoration of mobility, frequent removal of the apparatus is unnecessary; for too frequent removal may be hurtful, by allowing the recently elongated tissues to recontract during the time the apparatus is removed from the part.

Division of the hamstring muscles. We have shown that in a limited number of knee-contractures from disease and accident, section of the hamstring muscles may be required as a preliminary to gradual mechanical extension, or to abrupt violent extension under chloroform. In all cases after tenotomy, extension, whether gradual or abrupt, should be delayed until the healing of the punctures in the integuments. In the knee this healing is seldom complete until four or five days after the operation. The following rules may be given for severing the hamstring tendons: Place the patient in the prone position, and let an assistant make firm extension upon the joint, or desire the patient to endeavour to bend the knee, by either of which means the tendons will be rendered prominent. In general follow the directions laid down for division of the tendo Achillis (p. 572). In severing the tendon of the biceps femoris, insert the tenotome in the adult an inch above the apparent point of contact of the tendon with the fibula, remembering the proximity of the external popliteal nerve, and keeping, therefore, the tenotome close to the tendon. The semi-tendinosus being very superficial is readily severed by a puncture, where it springs up most prominently; the semi-membranosus being more bulky and fleshy, as well as more deeply seated, requires a larger sweep of the end of the tenotome. It is scarcely necessary to recommend caution as to the important nervous, arterial, and venous structures of the popliteal region. After section of the inner hamstrings, the pressure of the assistant's hands upon the limb being continued, bands of fascia and nerves make themselves prominently felt in the ham. Troublesome numbness in the calf, and unusual pain during extension, has followed the unnecessary division of these structures. It is desirable to apply promptly a pledget of lint and suitable pressure by a bandage over the punctures, to prevent oozing of blood into the areolar tissue of the ham, which affords an inconvenient nidus for suppuration. By adopting this immediate covering and pressure over the puncture, we have never witnessed delay in healing beyond four or five days, in ordinary moderate temperature. Very cold weather is apt to cause tenotomy punctures in limbs of weak circulation to appear, at the end of several days, as if they had been effected an hour previously, no attempt at adhesion being made. It is therefore proper in cold weather to envelop the limb in flannel, and assist the reparative powers of the patient by generous diet.

Division of muscles in the vicinity of the hip-joint. Though in hip-contractures the majority of the muscles proceeding from the pelvis on the flexed side of the part are contracted, experience teaches that few require operative interference. We have many times severed the origins of the adductor longus, adductor brevis, and pectineus, the tensor vaginæ femoris, and the superior origin of the rectus femoris. But of late years we have commonly restricted the operation to the tendon of the adductor longus, for the relief of tense abnormal approximation of the thighs, in cases of general spastic rigidity of the lower extremities. The adductor longus, from its position, exerts a relatively greater influence in morbidly adducting the thighs than other muscles. Its division is a satisfactory starting point for subsequent benefit from manipulation and use. It is effected according to the general principles of tenotomy, and requires no particular description.

Section of the tensor vaginæ femoris and rectus is suggested in certain cases of paralytic contracture of the hip, in which atony of the adductors of the thigh exists, a state of things opposite to the last-mentioned kind of case. Here the thigh is drawn from its fellow, the trunk tending to fall to the ground, as it were, between the thighs. Where contraction of these muscles exists, the paralysis of the adductors and other muscles of the hip (psoæ and glutei) is usually so considerable, that little radical good results from the operation. It should, therefore, as a rule, be superseded by manipulations, frictions, and mechanical appliances.

Division of the flexor tendons of the fingers and toes. The phalanges, when contracted from articular complaints, require treatment similar to that of the larger articulations. Commonly it is the flexor tendon which is implicated. Enough has been stated concerning the large ginglymoid articulations to render many details of treatment of these small articulations unnecessary. In operating on the fingers, we have to consider beforehand whether the articular disease has left the joint in a condition to resume its function as to movement; for if we may not expect to recover mobility, a straightened finger is not preferable to one partly bent. We require also to calculate the chance of the tendon when operated on in the course of the theca becoming agglutinated to the theca, and the finger subsequently on that account not regaining movement. In the foot, the most frequent affections of the toes for which Surgeons are consulted are those resulting from improper shoes worn during the growing period of the foot—in childhood and adolescence. The great toe is often thrust inwardly, and overlaps the next toe, the metatarso-phalangeal articulation being inflamed and ultimately deteriorated as to the normal condition of the articular surface, with consequent impairment of mobility. The joint is inclined to stiffen in the extended position after subsidence of the irritation or inflammation, the individual being prevented standing tip-toe, or ascending a hill without pain or inconvenience. This condition of things may, before and about puberty, be remedied by rest and suitable topical applications, followed by manipulations; the interposition of a partition between the toes, so as to keep the great toe in a proper line with the margin of the foot; and the temporary use of a suitably wide shoe.

Another common troublesome defect in the toes, similarly produced, though sometimes hereditary, is fixed flexion of the second toe. In children under the age of ten or twelve years, this defect can usually be remedied by light gentle bandaging (not tight) of the part, upon a padded whalebone splint, night and day, for a few weeks. In older subjects, and in peculiarly rigid cases, section of the flexor tendon, opposite the first phalanx, followed by bandaging on the splint, is a prompt and certain means of cure.

The little toe is often extended upon the metatarsus, or thrust laterally and sufficiently prominent to become continually a source of pain and irritation from the shoe. This also is often a congenital affection. Division of the extensor tendon and bandaging affords relief; but we have found this toe more obstinate than others.

The toes, and particularly the great toe, are often contracted in cases of varus, congenital and acquired. These contractions are relieved by the means taken to cure the talipes, and sometimes by gradually improving their position with suitable bandages.

Forcible extension. Under the head of *manipulations* and stretchings, the value of *gentle* employment of pressure and movements with the hands (passive exercise), both as a means of curing slight deformities, and as an important auxiliary to other methods of treatment, has been shown. If a larger measure of pressure or force be used with the hands, the treatment becomes that denominated *violent extension.* Here, as elsewhere, it is difficult to draw an arbitrary line, and say where gentle manipulation ends, and violent extension begins. In the practice of manipulations, the competent operator may frequently avail himself of the smaller degree of sensitiveness displayed by some patients, or of the momentary abstraction of the patient's volition from the muscles (a circumstance instantly felt by the hand of the operator), and apply an amount of force which approximates to, or may be considered as, violent extension. But *violent* extension with the hands is rarely efficacious in the removal of considerable contraction and deformity, especially in full-grown persons, because either the pain produced is intolerable, or the voluntary resistance offered by the muscles of the patient exceeds that at the command of the operator; a struggle is maintained between the patient's muscles and the Surgeon or rubber, in which the latter is commonly not victorious.

Through the inability of one person to effect, with any effort of his will, an extension forcible enough to overcome severe contraction, violent *sudden* extension, by means of the combined strength of several assistants, or by means of powerful screws, brought suddenly into action, was proposed and carried out, with varying success and misfortune, by Louvrier, Dieffenbach, and others. In the less severe cases of deformity, those indeed which are curable by gentler means, without longer duration of treatment, the parts were *suddenly* straightened by violent extension, without ultimately mischievous results, and the expected benefit was obtained. But in severer cases of deformity of many years' existence, in which organic changes of greater magnitude had taken place, as in severe knee-ankylosis, from extensive suppuration about the articulation, with necrosis, the violent separation of adhesions, and snapping asunder of bony deposits in the popliteal space and elsewhere, were accompanied with laceration of blood-vessels and nerves, fractures of the bones themselves, and consequent inflammation, suppuration, and even mortification, of the member. The plan was deservedly denounced, and fell into disuse.

Forcible extension under chloroform. Surgery received an invaluable addition to its means of usefulness by the discovery of the anæsthetic properties of ether and chloroform; and orthopædic practitioners, following the example of Langenbeck,* promptly availed themselves of the assistance these means are calculated to render in the cure of deformities. Hence the employment of forcible extension with the aid of chloroform or ether. By chloroformisation, the two great obstacles to the employment of force adequate to straighten or bend a contracted limb, namely, pain and voluntary muscular resistance, are removed. As soon as these impediments disappear, the hands of the single operator, and his single mind, applied to the parts, encounter the physical resistance only of the deformed parts; comparatively gentle manipulations now acquaint him with the nature and amount of difficulty; he can feel his way in the application of greater force; can feel and perceive the resistance of parts successively overcome, in an anatomical order; if greater rigidity still oppose, a few movements of the joint backwards and forwards prepare the way for a more extensive yielding; and often the practitioner has the satisfaction of being able thus to effect every natural movement of the joint.

Chloroformisation, with manipulations, and the use of a certain degree of force, may be of service as a means of diagnosis. By it the practitioner is enabled, in some degree, to ascertain what proportion of the deformity is due to shortening of soft parts, how much mischief the articular surfaces have undergone, and what amount of restoration is practicable.

After straightening or bending the limb, as the case may have required, by means of this forcible procedure, the part should be lightly secured in a retentive instrument or upon a common splint, adjusted so as to maintain a position more favourable than that in which the limb was before the operation, though not so as to keep it in the new position, *i. e.* the entirely straight or bent position into which the hands of the Surgeon may have brought it. For as soon as the effect of the chloroform disappears, the patient arouses to the conviction of the violence which may have been employed, the part may be acutely painful, and incapable of sustaining the pressure of a tight bandage or ligature.

We usually content ourselves with the increased knowledge obtained of the nature of the case, with the satisfaction of knowing that the part can be improved in form and function, and as the resisting parts have once yielded, that they will afterwards oppose less resistance to replacement; whether the means subsequently employed should be simple manipulations, the use of mechanical apparatus, or repeated administrations of chloroform, and forcible extension. The Surgeon who should attempt the forcible binding down of a long-deformed limb immediately after forcible extension, would betray a lamentable ignorance of the pathological condition of the parts in the immediate vicinity and within the diseased articulation. Although the muscular structures may have yielded under chloroform, and indurated fasciæ and old adhesions may have been overcome by stretching and tearing, it will be remembered that much adaptation on the part of nerves, blood-vessels, and absorbents to the altered position of the structures, needs to be accomplished. We find that, by taking moderate means of retaining as much improvement after the forcible extension as can be borne by the sufferer, by the unsparing use of lotions of spirit or ice, and by the internal use of morphia, dangerous inflammation of joints thus straightened has been averted. By employing afterwards the ordinary means of gradual extension, we have straightened joints which would otherwise have required many months of ordinary treatment.

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* *Commentatio de Contractura et Ankylosi Genu nova methodo violentæ extensionis ope sanandis*, Berolini, 1850.

It is perhaps not superfluous to remark, that the use of forcible extension is less defensible in cases of recent disease of articulations than even other active attempts to restore the form in such cases. In a diseased joint the practitioner has to note not only the local disorder, but also the general condition, of which the local affection is but one manifestation. When the Surgeon, with ability and experience, has cured the local disorder, *i. e.* removed the inflammation, healed the ulcerated or suppurating parts, or effected subsidence of pain, heat, and tumefaction, the consequences of the diseased action, contracture and rigidity, only remaining, he has not necessarily cured, by internal and general therapeutic measures, the morbid constitutional state. This often slumbers after subsidence of the local disease; and he should pause ere he too hastily undertakes the restoration of form and movements by forcible extension under chloroform, or by other active measures, and thus incautiously evokes a renewal of local disorder.

These views were enunciated* some years ago by the author, perhaps with more leaning to the employment of forcible extension;

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* *Treatise on Deformities of the Human Frame*, 1853.

latterly Mr. Brodhurst has largely employed and advocated this method. It will be found that violent extension is necessary in a relatively small number of cases, provided gentler means are suitably carried out. Orthopædy is capable of curing all those contractions in which the innervation is not hopelessly disturbed (severe paralysis and spasm), and those in which the synovial surfaces, cartilages, and articular extremities of the bones are not disorganised from disease. When we cannot hope to do more than straighten the limb, as in long-standing hip and knee contractions from articular diseases, violent extension under chloroform is most opportune as a means of obtaining a more useful position of the member.

In a few cases at the other extremity of the pathological scale, in which the will alone, or timidity, or the peculiar abnormal state of the system exists which is met with occasionally in young persons of both sexes, in whom, in consequence of slight injury, a limb remains stiff in the straight or bent position, the part is relaxed under chloroformisation, and the contracture is promptly and permanently cured. True hysterical contractures yield with equal facility during the anæsthetic state; but they usually return when the effect of the chloroform has passed off.

Mr. Brodhurst* has lately re-introduced section of the femur for rigidly ankylosed hip, in the hope not merely of straightening the limb but also substituting a new artificial joint for the ankylosed one. Although sufficient time has not yet elapsed to show whether this hope can be realised, the attempt is worthy of imitation.

W. J. LITTLE.

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* *Proceedings of the Royal Medical and Chirurgical Society,* 1862.

DISEASES OF THE BONES.

DISEASES of the bones may be conveniently divided into the following classes: *First*, inflammation and its consequences; under which head it is proposed to include the varieties of the inflammatory process, which have received the names of periostitis, ostitis, and osteomyelitis; and, as consequences of these, all the numerous conditions which have been confounded together under the common but vague designation of caries, the various forms of suppuration in bone, the varieties of necrosis, its effects, and those processes of repair which result in permanent modification of the structure and form of the organ. The *second* class will include the specific diseases, which occur either as modifications of the inflammatory process—syphilis, scrofula, and rheumatism in bone—or as constitutional conditions leading to changes in the bony structure: such are, mollities ossium, rickets,* and cancer. The *third* division will comprise a description of the various new formations found in the osseous system, and which are not dependent on any of the known constitutional cachexiæ. The *fourth* will treat of atrophy and hypertrophy properly so called, *i. e.* uncomplicated by inflammation.

SIMPLE INFLAMMATION AND ITS CONSEQUENCES.

Inflammation of bone differs from inflammation of soft parts, not in its essential, but in its accidental, features; the inflammatory process is the same, but the conditions or circumstances are different, and hence arise diversities in rate of progress, in external appearance, and in other symptoms; diversities which, although they are not really essential, yet cause striking differences to ordinary observation, and have led to the designation of the results of inflammation in bone by names differing from those which are used for the same changes in soft parts. This difference in nomenclature, though it might arise in mistake, at a time when necrosis was thought to be something essentially different from gangrene, and caries a disease which had little in common with ulceration, is yet hardly to be regretted, since the diseases of bone, though pathologically identical, are practically very different from those of soft parts; and it is convenient to have separate names for things which require very different treatment, and entail a very different amount of danger.

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* The subject of Rickets, however, will not be found here, as it has been thought better to refer it to the SURGERY OF CHILDHOOD.

If the reader will refer to the essay on INFLAMMATION (vol. i.), he will find abundant information on the early steps of that process. These affections are identical in bone and in soft parts; in fact, they can occur only in the soft parts of bones, since the mere inorganic matter, which, involved in the convolutions of a cellulo-fibrous and vascular network, constitutes a bone, can itself be the seat of no vital actions, but must obey the movements impressed upon it by the living textures around.

In Von Bibra's "Essay on the Decomposition of Bone by Caries"* will be found a good deal of interesting information on the chemical and microscopical characters of bone in inflammation; and from this author's researches it appears clear, that the changes in the inorganic constituents of bone are often limited to the dissolution of that connexion which previously united them to the organic matrix, so as to form one system. This connexion having been severed, portions of the salts are washed away in the discharges, and they may be found, according to Von Bibra's account, in unaltered chemical composition, while the composition of the organic constituents of the same part is profoundly changed, principally by that fatty degeneration which occurs in all inflammations. The inorganic constituents must, however, in some cases of inflammation, undergo other changes, since they may disappear in large masses, without any discharge having been present. Thus in caries of the spine, or in inflammation excited by the pressure of tumours, it is not rare to find that large portions of the vertebral column have been removed, sometimes to such an extent as to expose the spinal canal; yet no abscess has formed. The older pathologists made a distinction between these cases and those of caries, founded on the presence of pus in the latter, and its absence in the former; but this distinction, though of great practical importance, does not indicate any pathological difference. Both are inflammatory processes, though of different degrees: the one, ulceration attended by suppuration; the other, ulceration attended by liquefaction only. From this fact of the disappearance of masses of hard tissue, without any discharge in which they can have been washed away, it seems clear that the small earthy particles thus loosed from their natural connexion with the organic matrix may undergo a reversal of the process by which they were deposited out of the fluid blood; *i. e.* may become again soluble, and pass into the venous current.

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* *Liebig und Wohler's Annalen*, vol. lvii. It will be found useful to compare this essay with those of Mr. Barwell and Dr. Black, referred to further on.

The earliest microscopical change* is an unusual fulness and distinctness of all the vascular cavities of the bone; the Haversian canals, lacunæ, and canaliculi being all more sharply marked than in the natural state. This Von Bibra compares to the injected condition of soft parts. Later on, the Haversian canals and lacunæ become widened; the latter disappear in consequence of the communication of neighbouring cavities, and spaces are formed in the bone, filled with fat and earthy salts, the detritus of the decomposed tissue.

The earliest change in the consistence of bone, produced by inflammation, appears to be softening; as a consequence of the loosening and absorption of the mineral portion, and the liquefaction and conversion into fat of the organic matrix. Mr. Barwell has recently published an interesting essay "on Osteitis,"† which affords, perhaps, the most distinct demonstration of the enlargement of the vascular spaces at an early period of inflammation. In this essay, Mr. Barwell teaches that the earliest stages of inflammation are accompanied by induration; an assertion which I venture to question, since it appears to me that induration is a phenomenon subsequent in order to the inflammatory process in its stricter sense, and due to one of its results, viz. effusion. The reader is referred to the original essay, which will well repay perusal.

Such are the earliest changes in the minute structure and consistence of inflamed bone. The changes which take place in its rough anatomy may be thus described. If a bone be examined at an early period of inflammation (the ordinary and most accessible instance is the stump of the bone in an amputation fatal, say, three weeks after the operation),‡ the periosteum will be found somewhat thickened, vascular, and not so closely connected to the bone as usual.* If the periosteum be stripped off, the bone is seen to be irregularly vascular, some portions of it having a slightly red tint, and contrasting with the healthy white colour of the rest of the bone. This red tint is evidently caused by the enlargement of the vessels which pass from the periosteum into the bone; and if a magnifying-glass be used, the increased size of the vascular apertures is easily proved, while if pressure be made on the surface of the bone, drops of blood will frequently ooze from the mouths of the enlarged vessels, proving their increase in size, as well as the loss of consistence in the outer hard wall of the bone. At the same time there will be found, in all probability, on some other part of the surface, more or less deposit of osseous matter, which, with the partial separation of the periosteum above mentioned, testify to the fact of effusion from the vessels of that membrane. In these simple cases of injury the deeper parts of the bone will probably be unaffected; but should this not be the case, *i. e.* should inflammation have also attacked the membrane lining the medullary cavity and cancelli, that membrane will be found in a condition essentially analogous to that of the periosteum, although the different situation of the medullary membrane, and the great quantity of fat and other loose tissues among which its vessels run, will somewhat modify the external appearances. If, however, these appearances be minutely investigated, they will be reduced to, increase in the number and size of the vessels, and effusion of blood, lymph, or pus, according to circumstances. The thickening both of the periosteum and of the medullary membrane is sometimes considerable. The former membrane is, of course, more frequently found thickened than the latter; but preparations showing the participation of the medullary membrane in inflammation of the bone, and the identity of its appearance with that of the thickened periosteum, are not wanting.†

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* See Von Bibra, op. cit.

† *Brit. and For. Med.-Chir. Rev.*, April 1860, pp. 460 et sqq.

‡ In such a specimen the periosteum will generally be found stripped off from a small ring at the lower end of the bone, and this part will perhaps be dead or about to die; but as this feature is accidental, it will not be further noticed.

Thus we see that when inflammation commences, as it usually does, on the surface of a bone, whether periosteal or endosteal, its primary symptom is increase in the size (and perhaps number) of the capillary vessels, or vascular spaces, and effusion of blood or lymph. The primary effects of inflammation in the central parts of the compact tissue are similar to the above; though here, from the different circumstances in which the vessels are placed, this similarity has been less distinctly perceived; and from the slowness with which all changes go on in the compact tissue, opportunities rarely occur of comparing the different parts of the same bone with each other. The first change is the enlargement of the vessels which run in the Haversian canals; but effusion is a much later phenomenon, and is preceded by the absorption of the bony tissue which adjoins the enlarged vessels; so that in microscopical sections of inflamed bone, the Haversian spaces are seen much enlarged, irregular, eroded, and sometimes almost, or quite, communicating with each other. The lacunæ may also be noticed to be densely crowded together, and sometimes the granular matrix of the bone appears more coarse than natural. When this absorption of the walls of the Haversian canals becomes visible to the naked eye, the first change in the rough anatomy of inflamed compact tissue becomes appreciable—that in which spaces are seen in it on section like those in cancellous tissue, so that it is sometimes said to become cancellous. Similar changes occur in the cancellous tissue itself, whereby its cells become much enlarged, and sometimes the whole bone is expanded by the simultaneous yielding of its walls.*

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* Hunter has put up (Mus. Coll. of Surg. no. 656) "A preparation of a femur, which was amputated, with the periosteum separated; to show how clear the periosteum separates from the bone in inflammation; a fact almost always observable after amputation."

† One of the most striking preparations of this kind is in the museum of St. Bartholomew's Hospital,—a humerus, series i. no. 207.

Into the spaces thus hollowed out in the substance of the bone, or on its surface, by the removal of the earthy matter, the products of inflammation are next secreted. These secretions vary, of course, according to numerous preceding circumstances, *e. g.* the nature of the injury, or other cause of inflammation, the activity of the process, the constitutional condition of the patient, and a thousand others; and so the products of ostitis are divisible into two principal varieties, corresponding to the plastic and aplastic lymph met with in other parts, and leading, the former to the deposition of earthy matter and the formation of new bone, and the latter to suppuration. The former result terminates in hardening, or *sclerosis*, as it is termed; the latter in a variety of conditions: when the suppuration is limited within a cavity in the cancellous tissue, or in the compact tissue rarefied by previous inflammation, circumscribed abscess is produced; when the pus extends along the inner surface of the membrane lining the medullary cavity and cancelli, the condition of bone exists which is usually spoken of by English authors as "diffused suppuration," and by the French as "osteomyelitis;" suppuration between the periosteum and bone forms periosteal abscess, acute or chronic; and any of these forms of suppuration, when accompanied by the insensible exfoliation of the bone (or its death, and removal in invisible portions), constitutes ulceration of the bone, or *caries.* Lastly, inflammation of the bone sometimes leads to the death of larger portions of its tissue, which are then removed by the process of ulceration, as in soft parts. This constitutes gangrene of bone, or *necrosis;* but as that condition, like other forms of gangrene, is often produced by other causes not inflammatory, the whole subject of necrosis must be treated by itself.

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* See a description, by the author, of the bones of the lower extremity ten months after excision of the knee, where the superficial laminæ of the femur had been so separated from each other by inflammation that the bone crackled under the pressure of the finger. *Path. Soc. Tr.* vol. xii. p. 171.

We have now to consider separately the causes, symptoms, and treatment of each of those phases of the inflammatory process; the above being intended only as a kind of ground-plan, to mark out the various parts of a rather intricate subject, each of which must be studied in detail.

Ostitis. Inflammation of bones is excited usually by external violence, or exposure to cold, acting upon a constitution predisposed to the disease. The predisposing causes are, the syphilitic or scrofulous taint, rheumatism, defective nutrition, &c.; or these may themselves set up inflammation in any bone, without a distinct exciting cause. From this mode of causation it follows, that the bones most liable to inflammation are those most exposed to the action of external agents. Hence we see it most frequently in the tibia among the long bones, and in the skull, sternum, and ribs among the flat bones. The bones of the foot and hand are also very frequently affected.

Ostitis is a very common affection, although not much recognised; partly because, from the little attention it has received from our older authors, and from the fact that most swellings of bone are regarded as periosteal, we are not much in the habit of looking for it; and partly because its symptoms are at first obscure, and liable to be masked by those of the injury to the soft parts with which it is associated, or of the constitutional affection from which it springs.

The symptoms vary according to the stage of the inflammation. In the first stage, that in which the size of the vessels is increased, and in which absorption is being produced, the disease frequently makes considerable progress without appreciable symptoms.* Sooner or later, however, the occurrence of those characteristic dull pains in the bones, exacerbated by changes of weather, increasing in severity during the night, and somewhat resembling the pains of rheumatism, which are described by French writers as "douleurs ostéocopes," draw the attention of the patient to the seat of the disease, and form a valuable guide to the Surgeon. If the part be now examined, the probability is that some evidence will be found of inflammation in the tissues surrounding the bone—œdema, redness of the skin, tenderness of the soft parts, or threatening abscess. The absorption of the earthy material, which accompanies this increased vascularity, manifests its effects upon the bone by a diminution in its consistence, and then the bone becomes at the same time increased in volume and diminished in its resistance to pressure. The former symptom is indeed somewhat delusive, since the apparent increase is often due principally to enlargement of the soft parts. Thus, the expansion of the joint-ends of bones, which frequently appears so considerable in chronic affections of the joints, is often reduced to a hardly appreciable enlargement on dissection. But the swelling of the bone may sometimes be made out very clearly, and is then a valuable indication of the disease. The softening is not generally of much importance as a diagnostic symptom; it rarely affects the whole thickness of a bone, so as to lead to a change in its form, and, when limited to a portion of the surface, cannot be appreciated by the touch, since the inflamed and irritable condition of the soft parts renders the patient unable to bear the necessary pressure.

A singular change, which sometimes follows inflammation of a long bone, is its elongation. In a paper, recently presented to the Royal Medical and Chirurgical Society, Dr. Humphry has laid much stress upon the consequences of diseased conditions of the epiphysial lines near the ends of long bones, as affecting their subsequent growth. It is possible that inflammation of this tissue may have led to the elongation of the bone in some of the cases; as in a tibia from a lad æt. 18, preserved in the museum of St. Bartholomew's Hospital, in which the bone has become lengthened, and is curved in order to adapt its length to that of the healthy fibula.

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* This is true more especially of the earlier stages, but is occasionally observed in all forms of inflammation of bone. Thus large psoas abscesses, connected with extensive erosion of the vertebræ, are found sometimes in patients not of a strumous habit, and who have not been known to present any symptoms of such an affection.

To the stage of absorption and rarefaction succeeds that of effusion and deposit, unless the process be arrested, and resolution occur. The various consequences of suppuration being reserved for subsequent sections, we need now only consider that termination of inflammation of bone in hardening or sclerosis, which corresponds to the inflammatory solidification of parenchymatous organs; and which, when not too extensive, is for practical purposes little less desirable than complete restoration to health. The interstices of the cancellous tissue are filled up at first with lymph, in which ossific matter is afterwards deposited; and then the bone, which, while actively inflamed, had been less dense than in its healthy condition, becomes hard, heavy, and solid; the medullary canal is narrowed or filled up, and the shaft thickened by deposit from the periosteum. Bones thus affected abound in every pathological collection; and it is easy to trace in them many of the appearances of which an explanation has been attempted above—the large size of the vascular apertures, the irregular deposit of bone, both in the centre, the substance, and on the surface of the shaft, the contraction of the medullary cavity, and usually the increase in size of the nutritious foramina. It will generally, but not always, be noticed that these changes are limited to the shaft of the bone, when it is the part first affected, and that the articular ends escape. The converse is also usually the case; though perhaps the shaft is more prone to become involved in the morbid actions of the joint-ends than the joint-ends are in those of the shaft. Thus inflammatory affections may long go on in the shaft of the femur, yet the knee-joint remain unaffected; and, on the other hand, in most diseases of the joints, the affection of the bones considered by itself is not so extensive as to contra-indicate excision. To each of these two general rules, however, numerous exceptions will, unfortunately, be met with in practice.

Inflammation of the bone is almost always known, in common parlance (when it is recognised at all), as *periostitis;* but, in truth, periostitis seldom occurs uncomplicated, unless in the course of secondary syphilis;* and almost all the cases which pass under that name are really inflammations, more or less extensive, of the bone. That this is so, will hardly be doubted by any one who considers how few preparations of pure periostitis can be found in our museums, and how seldom, during our post-mortem examinations, we meet with periostitis unattended by inflammatory deposit in the deeper parts of the bone. The symptoms, as well as the morbid anatomy, of both are identical, only that in periostitis the thickening and vascularity involves no other part of the nutrient membrane of the bone except the periosteum, and that the inflammatory deposit is confined to the surface of the bone, between it and the periosteum. Periostitis is a quicker process, and one more under the influence of remedies than the other forms of inflammation of bone; but in all the same general course of treatment is indicated, viz. the internal administration of iodide of potassium, and local application either of iodine or mercurial ointment, or perhaps, in the early stage of the disease, of blisters. These measures should be combined with proper position of the affected member, and as much rest as is consistent with attention to the general health. Leeches or cupping will afford relief if the pain be severe. When there is much tension over the bone, sometimes accompanied (especially in the cranium) with intolerable pain, nothing gives such immediate and decided relief as a free and bold incision down to the bone. The distended periosteum is thus relaxed; and in cases of pure periostitis such a measure may of itself almost suffice for the cure of the disease; but its beneficial effects will be decided, though less striking, in cases of deeper-seated inflammation. In cases of chronic inflammation of bone, accompanied by deep-seated and wearing pain, an opening made with a trephine, for the evacuation of pus, has proved beneficial, even though no pus was found.*

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* I would refer the reader to the section on Syphilis in Bone for further details on the subject of chronic periostitis.

Whether the sclerosis, or induration, which is the final result of chronic inflammation, be amenable to any remedial measures is doubtful, since it usually gives the patient little inconvenience, and therefore is not made the subject of treatment. Thickening over the bone is often left after ostitis, and is often dispersed by the ordinary measures, such as friction and pressure; but the seat of this thickening is very generally in the soft parts around the bone, and not beneath the periosteum.

Diffuse periostitis. Inflammation of the bony tissue itself is rarely acute, and when it does occur in the acute form passes rapidly into necrosis, under which head it will be presently spoken of; but acute inflammation between the bone and periosteum, *diffuse peri-*

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* See a case reported by Sir B. Brodie, in his *Lectures on Pathology and Surgery*, p. 410. On the good effects of a free incision of inflamed periosteum, when milder measures fail, see Sir P. Crampton on Periostitis, *Dublin Hospital Reports*, vol. i. p. 331.

ostitis, is a disease of rather frequent occurrence, and is less noticed in surgical works than its importance would seem to require. It is seen commonly enough in persons about the age of puberty; more frequently in boys than in girls; usually as the result of some injury, and almost always in one of the long bones. It is so destructive in its effects, so rapid in its course, and is so little recognised, that we have unfortunately numerous opportunities of verifying its existence after the time for treatment has passed away; yet to early and vigorous treatment it is tolerably amenable, at least as amenable as so acute a disease can be expected to be.

The pathology of the disease appears to consist in the partial separation of the periosteum from the bone, by effusion on the surface of the latter of lymph, or other products,* soon giving place to a copious formation of pus, which spreads along the whole bone, and dissects away the periosteum from it, often from one end of the bone to the other. If examined at an early period of the disease, the periosteum does not (at least it very often does not) display any distinct signs of inflammation, either in change of colour or of thickness; nor is the surface of the bone visibly inflamed. On the contrary, it usually looks white, and inclined to gangrene, a consummation which rapidly impends over such cases. Sometimes, however, the surface of the bone may be found slightly worm-eaten, and on squeezing it, its superficial layers are found more readily separable from the deeper tissue than in health; large drops of blood can in such instances be pressed out of the vessels which pass into the bone from the periosteum. A little later, and necrosis is unmistakably declared, and the whole diaphysis usually perishes, leaving the articular ends unaffected, and therefore not involving the neighbouring joint. The joint, however, does not always escape. A boy was admitted into hospital several days after an injury, with great swelling of the fore-arm, evidently depending on the formation of matter. A grating sensation, perceived on rotating the hand, together with the history of the accident, led to the belief that fracture had occurred. He died of pyæmia; and then it was discovered that a periosteal abscess, extending from the shaft of the radius into the wrist-joint, had so eroded the articular cartilages as to occasion the sensation of crepitus.

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* The disease does not commence by the formation of abscess; often when the swelling and inflammation are considerable, no pus will be found. Of this fact the following is an instance. A lad was suffering from what was supposed to be diffuse cellular inflammation around the ankle after a slight injury. As it was suspected that the inflammation was really subperiosteal, an incision was made down to the tibia. No pus followed. Two days afterwards the boy presented obvious symptoms of confined matter, and now by breaking up the adhesions of the wound a copious evacuation of pus was obtained, and the surface of the bone was felt exposed. A few days later, swelling and tenderness were found over a higher part of the tibia. The Surgeon, thinking that on the former occasion he might not have divided the periosteum freely enough, now took care to press the edge of the knife firmly against the bone for some distance. Matters went on exactly as in the former wound. No pus was found at the time, but on breaking down adhesions, two days later, with a probe, the pus was discharged, and bone felt exposed.

The course of the disease is usually as follows: it commences in the great majority of cases with an injury of more or less severity, occurring to a person generally of the strumous constitution, at any rate a weakly person; the symptoms which immediately follow the injury are usually slight, so that even the occurrence of the accident is perhaps nearly forgotten; then, after a varying lapse of time, probably four or five days, symptoms occur which are almost invariably attributed at first to diffuse cellular inflammation, or to acute rheumatism, viz. rigors, pain in the part, and an œdematous angry swelling. At the outset the diagnosis is not easy; indeed, before suppuration has occurred, perhaps no certain diagnosis can be made. However, as respects diffuse cellular inflammation, the age of the patient, the comparative remoteness of the cause, and the previous immunity of the superficial parts, will lead to a suspicion of the nature of the case, which will be strengthened when the inflammation is seen to be limited to the section of the member first affected, instead of passing the joint, and spreading up the limb, as an erysipelatous affection would in all likelihood do, and will be converted into certainty by the discovery of deep-seated matter, either by fluctuation or on puncture. Fluctuation cannot always be detected, since the tension of the membranes which bind down the pus, and the tenderness of the superficial parts, combine to oppose its discovery. Exploratory punctures, however, should never be neglected. If the disease be merely superficial, they can do no harm; and it is of vital importance to discover early, and give instant exit to, the pus before it has dissected off large portions of the periosteum, and involved the death of a great part of the bone. The diagnosis between a case of this sort and one of acute rheumatism will depend upon the nature and history of the disease, and on the presence or absence of constitutional symptoms of rheumatism, or rheumatic affections of remote parts. At the outset of the case the diagnosis may not be very confident; but the main point to recollect is, that any periosteal affection, if acute, is liable to run early into suppuration, and that in such cases, whatever view may be taken of the origin of the disease, whether it is to be considered rheumatic or otherwise, the local treatment is far more important than the constitutional. What Sir P. Crampton says of the acute periosteal whitlow applies with much greater force to acute periosteal affections of the larger bones: "there are few diseases where art can do so much and nature so little."

If the disease be allowed to go on unchecked, the whole circumference of the limb will become greatly swollen and œdematous, usually with that tense glistening aspect which tells of subjacent suppuration. The patient mostly complains of great pain, especially acute at night; he loses appetite and flesh rapidly. Pyæmia is very liable to occur, and many of these patients die of it. A few die exhausted by the violence of the action, and by the profuse suppuration. If the patient survive, and the abscess do not obtain a free and depending opening by timely incisions, it will burrow among the muscles, and ultimately numerous openings will form, exposing necrosed bone. The dead bone appears to separate much sooner than in other forms of necrosis, and the repair to be proportionally active. Thus, in an adult, almost the entire length of the shaft of the ulna was thrown off and removed three months after the injury which led to the complaint; and, even at that date, the repair appeared to be far advanced. In less acute cases, where only a portion of the surface of a bone is involved, the disease pursues the ordinary course of necrosis.

The subjects of this affection are almost always young persons,* in whom the strumous diathesis is well pronounced; but it occurs more rarely in healthy subjects about the age of puberty, or even earlier; and some cases are observed (as the one to which allusion has just been made) in adults of impaired constitution and dissipated habits.

The bone affected is, in the great majority of cases, the femur; and it is no doubt in consequence of the great size of this bone, and the severe effects which always attend upon a large abscess situated at so great a depth, that the disease is so fatal. But reference has already been made to two cases in which the bones of the fore-arm were attacked; and any of the long bones may be, and is not unfrequently, the seat of the disease. The flat and irregular bones are more rarely affected; but Sir P. Crampton's case* is well known, in which an acute abscess formed beneath the periosteum of the bones of the nose and cranium on both sides.

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* Chassaignac says, that out of eleven cases, only one had passed the seventeenth year, and was below twenty-one; and one was only eleven months old. A circumstance which seems to testify to the effect of a constitutional predisposition is mentioned by the same author, viz. that in some cases several acute periosteal abscesses have been present in the same subject. *Mém. de la Soc. de Chir.* vol. iv. pp. 286-7.

The treatment of acute periosteal abscess is a matter of the greatest importance, as it is only by vigorous measures that so rapid and dangerous an affection can be relieved. Among these measures, the first and most important is to make timely and sufficient incisions into the swelling. If doubt exist as to the nature of the swelling, or as to the situation of the pus, they will be settled by the grooved needle; but even if no pus be found, it is better in any case of periosteal inflammation, where the pain is great, to make an incision down to the bone in the part to which such pain is referred. In children, it will be advisable to administer chloroform before commencing the examination, when the affection is deep-seated.

During the acute stage of a periosteal abscess, free exit having been obtained for the matter, the patient must be treated on general principles; no special internal treatment is necessary for the affection of the bone. The indications are, to allay pain, to support the strength, and to avoid, if possible, the constitutional affection which leads to pyæmia. The last is the most important of all; patients seldom die of the "surgical fever," so called, which is usually present; they seldom die of the exhaustion of the discharge; but they die by pyæmia in a large percentage of the cases. How great the mortality is, it would be difficult to say, since the disease is not generally recognised in our nomenclature; but out of a comparatively small number of cases which have occurred during the last few years in the surgical wards of St. George's Hospital, a very large proportion have died of pyæmia. Free and early incisions give the patient the best chance of escaping this fatal complication. No fear need be entertained of decomposition of the pus from the admission of air. In fact, pus which is confined over a bone, in an acute inflammatory disease, will probably be already sufficiently putrid. The openings should at first be made in as depending a position as possible, and they should be so free as to preclude all risk of their closing again. After the opening of the abscess, free stimulation is generally, if not always, necessary. The patient will, perhaps, be unable at first to take solid nourishment, since these affections are generally attended with severe fever; but as soon as the evacuation of the matter has removed some part of the irritation, his appetite will probably return.

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* *Dublin Hospital Reports*, loc. cit.

In abscesses which are at once deeply seated and small, it may sometimes be advisable to use a drainage-tube; but in most cases the collection of matter is too extensive to allow of this treatment being beneficially adopted, at any rate till a later period of the case, when the abscess is contracting and the incisions show a tendency to close. In the memoir of M. Chassaignac, already referred to, the author speaks highly of the advantage of injections of very dilute hydrochloric acid, which have the effect, according to him, not only of cleansing the suppurating cavity, but also of hastening the removal of superficial exfoliations by dissolving the dead bone.

If the patient has survived the acute stage of the disease, the abscess may long remain in a chronic condition, exposing the bone. In the more favourable cases, the outer shell only of the latter has perished; while in the most severe, the entire shaft, separated from the epiphyses, may come away in a mass; or even the epiphyses themselves may share in the destruction, though that is very rare. The treatment of these sequelæ of diffuse periostitis will be spoken of in the section on Necrosis.

Osteomyelitis. Diffuse inflammation, and suppuration, in the cancellous tissue, an affection to which French pathologists have given the name of "osteomyelitis," is more frequently recognised in post-mortem examinations than at the bedside of the patient. It is closely allied to pyæmia, and is usually, or at any rate very frequently, followed by that mode of death. It bears the same relation to the medullary tissue as the complaint just spoken of does to the periosteum; but the difference in character between the periosteum and the medullary tissue, the latter being so much more rich in vessels, especially in large patulous venous channels, gives to osteomyelitis a gravity even beyond that of diffuse periostitis. It is well known how often diffuse suppuration is found in the diploë of the cranium after scalp-wounds, and how the "puffy tumour of Pott" is frequently only the sign of such suppuration; and further, in what a large percentage of such cases evident pyæmia is found. It is probable that in all these cases the external table of the bone has been wounded, and the diploë thus exposed; in fact, the only known cause of osteomyelitis is a wound which exposes the cancellous interior,* or an injury to the interior of the bone, perhaps unaccompanied by external wound, as in fracture. It is a frequent cause of death after amputations and other surgical operations in which bone is divided.

When a bone is examined in which osteomyelitis has run an acute course, the cancelli are found loaded with pus, and the medullary tissue usually injected and often sprinkled with ecchymoses: the periosteum also is often in the course of separation from the bone; but the bony tissue itself does not generally show any appreciable change. In the larger bones the disease usually terminates fatally at this stage; but should the patient survive, the pus may penetrate into neighbouring parts, most probably into the nearest joint, or central necrosis may result. Specimens to show either of these terminations are not wanting in our pathological collections. Thus, in the museum of St. Bartholomew's Hospital there is a beautiful specimen† of inflamed and thickened medullary membrane of the humerus, which shows, as a consequence of the inflammation, a portion of cancellous tissue exfoliated and lying loose in the medullary canal. A long fistula leads through the tube of the bone into the elbow-joint. The same museum possesses another specimen,‡ in which acute diffused suppuration, spreading through the tissue of many of the long bones, has caused abscess in the knees and ankles on both sides.

The symptoms of this grave affection are exceedingly obscure: it, like other extensive and acute affections of bones, is often accompanied by diffuse inflammation of the soft parts, which then masks the deeper affection. The only known special symptom is the separation or recession of the periosteum from the bone, accompanying diffused pain in the bone, and not caused by effusion on the external surface of the latter. After amputations, a prominent fungous mass is often seen projecting from the end of the bone, and proves the existence of a certain extent of inflammation of the medullary tissue; but this need not necessarily have affected the bone so extensively as to deserve the names of osteomyelitis; in fact, that affection is seldom recognised before death.

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* Unless the infection of constitutional syphilis should be added. See infra, on Syphilis in Bone.

† Series i. no. 207.

‡ Ibid. no. 195. See also no. 104, a preparation in which the whole of the inner portion of the os calcis is separating from its outer wall, as a consequence of diffused suppuration through its cancelli.

To obviate the formidable dangers, and the extensive disintegration of parts connected with osteomyelitis, it is justifiable in any case where pain in the bone, accompanied with the ordinary symptoms of acute suppuration (rigors, fever, &c.), but without signs of external or periosteal mischief, induces a reasonable suspicion of this affection, to expose the surface of the bone by a free incision. Should the periosteum be found separated, or even separating, from the bone, the diagnosis of diffused suppuration in the cancelli will be rendered highly probable. When this separation has proceeded to any great extent, amputation of the member, or excision of the diseased bone, is certainly indicated; or, if the Surgeon be unwilling to proceed to such radical measures, it may be a question whether the use of the trephine, or other perforating instrument, may not give the patient a better chance of recovery. Such operations have at least been successful in relieving the symptoms, when undertaken for the cure of supposed abscess within the bone. It should be remembered that the disease is a rapid one, the fatal complications of internal phlebitis and pyæmia imminent; and therefore treatment, to be effectual, must be adopted early. Medicine, as might be expected, has little effect on the disease; but the fever which accompanies it should, of course, be treated on the ordinary principles. Finally, in deciding on the question of removing the disease (an operation which would in ordinary cases be held to be counter-indicated if pyæmia had set in), it should not be forgotten how much the early symptoms of systemic infection resemble those of typhoid fever;* so that it may be proper in doubtful cases to give the patient the benefit of the doubt, and attempt to relieve him from the source of irritation.

Chronic abscess. Limited suppuration, or abscess in the cancellous tissue, is an affection which is fortunately far more easily recognised, and far more under the control of Surgery, than osteomyelitis. It hardly needs to be said that this condition of bone was first discovered and described by Sir B. Brodie.† The symptoms are not always very clear, but a careful study of the case seldom fails to establish the correct diagnosis. The seat of the disease is almost always the articular extremity of the bones which form one of the great joints—knee, ankle, or elbow. The tibia is more frequently affected than any other bone, and usually at its upper end.

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* See vol. i. p. 267.

† *Lectures on Pathology and Surgery*, ed. 1846, p. 395.

Chronic abscess may, however, occur in any situation.* The abscess is almost always situated on the superficial side of the bone, and is probably occasioned, in most cases, by external violence, or other causes, acting on that surface; but the history is often obscure, in consequence of the chronic nature and insidious progress of the malady.

The symptoms are, a dull aching pain in the part, often worse at night than during the day, liable also to other remissions and exacerbations, and increased by exercise or pressure. In most cases the bone is especially tender at one particular spot, where the abscess has advanced nearest to the surface, and there is slight tumefaction of the soft parts over it. Sometimes, but not always, a little enlargement of the bone itself may be made out. There is perhaps nothing very characteristic in these symptoms taken separately, or on a first examination; but the persistence of the whole assemblage of them for a considerable period of time, and in spite of judicious treatment, directed to subdue an inflamed condition of the bone, will be reasonable ground for the diagnosis of chronic abscess, and more especially if the neighbouring joint be unaffected. The localised, and very circumscribed, tenderness is perhaps, when well marked, the most unmistakable symptom.

The condition of the diseased bone testifies very clearly to the nature of the morbid process, so that few museums are without some of these preparations. The following is Sir B. Brodie's description of the first preparation which he dissected:† "The lower end of the tibia is enlarged, and the surface presents marks of great vascularity. The bone in the preparation is divided longitudinally, and just above the articulating surface there is a cavity as large as a small chestnut. This cavity was filled with dark-coloured pus. The inner surface of it is smooth. The bone immediately surrounding it is harder than natural."‡

If the case be allowed to proceed beyond this stage, serious, and frequently fatal, mischief may ensue from extension of the abscess into the neighbouring joint. Before this event occurs, however, the patient may be much inconvenienced by repeated attacks of swelling and pain in the joint when he attempts to use the limb, the effects of slight synovial inflammation set up by the neighbouring abscess. Rest and cold applications will generally remove these symptoms, but only to recur as soon as the patient again attempts to move about. On the cure of the abscess they will immediately and permanently disappear. When the abscess has burst into the joint, the affection of the bone becomes merged in the more serious injury to the articulation.

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* In the museum of St. Thomas's Hospital there are examples in the body of a rib, in the clavicle, and sternum, series C. nos. 84, 84^2, 85.

† The original preparation is in the museum of St. George's Hospital, series ii. 30.

‡ Op. cit. p. 397.

Treatment. In all cases, as soon as the diagnosis has been so far settled as to satisfy the Surgeon that operative interference is justifiable, he ought to explain the nature of the case to the patient, and endeavour to obtain his consent to the simple operation which will at once establish the diagnosis and cure the disease. There is not generally much difficulty in obtaining the consent of the patient, whom long-continued suffering and enforced inactivity have rendered greedy of any chance of relief. Chloroform should be administered, and the suspected part of the bone well exposed by a crucial incision. The bone should then be perforated to a considerable depth with a small trephine, which should not have a shoulder. If one spot on the surface of the bone appears softer than another, this should be selected for the centre of the opening. Very often pus will be seen welling up in the groove, as soon as the trephine has penetrated the compact wall of the bone. The instrument may then be withdrawn, and on the circle of bone being raised with an elevator, the pus will be evacuated. The cavity exposed is lined with a thick "pyogenic" membrane, and its surface is very sensitive. The pus is only in small quantity (generally about a tea-spoonful); but its evacuation suffices at once to relieve the patient of his wearing pain, and he is soon restored to perfect health, the cavity being filled up with a fibrous material, by which in all probability the excised piece of bone is ultimately reproduced.

Two things may interfere with the complete and immediate success of this operation,—the diagnosis may have been correct, but the place selected for trephining may have been not quite the right one; or the diagnosis may have been wrong, and the symptoms have depended merely on chronic ostitis. In the latter case, as may be seen by Sir B. Brodie's patient above referred to (p. 623 note), the operation will often do good, will relieve the pain of the inflammation, and perhaps prove the starting-point of a healthier action. It is well, however, remembering that this mistake has been committed by the best Surgeons, to prepare the patient for it, so that he may not be too much disappointed if the Surgeon shall afterwards have to confess that no pus was found. If, however, the trephine do not come down upon an abscess, it should not be forgotten that this may depend on the opening having been made on one side of the abscess, which may be lying close to the trephine hole, but separated from it by a thin bony septum.* It is advisable, therefore, when the pus has been missed, before giving up the operation, to pierce the walls of the trephine-hole in several directions with a sharp-pointed instrument, in order to remove the bone freely with a chisel if a drop of pus follow any of these punctures.

Caries. The word caries will be used in the sequel as equivalent to the term "ulceration of bone." It is true that some pathologists of the greatest authority have limited the use of the term caries to scrofulous ulceration, and others have sought to establish a generic difference between caries and ulceration. As to the latter point, however, I must confess that a careful perusal of works in which caries and ulceration are treated of under separate heads, has failed to make me see the distinction which the writers wished to establish; and with reference to the former, although there is as much difference between strumous ulceration and simple ulceration, when occurring in a bone, as there is between the same processes in soft parts, I cannot see that there is any more reason to attach a special name to the process as occurring in bones than in other tissues, while confusion is certainly occasioned by the use of a special term in many cases where the strumous nature of the process is only a matter of inference.

Superficial ulceration is distinguished by the following characters. The periosteum is loosened from the surface, and, if the disease is advanced, will be found much thickened, and converted into a villous mass of a pink colour, resembling a layer of granulations. This substance adheres very loosely to the surface of the bone, and, when lifted up from it, is found to fit into depressions, which seem to have been hollowed out of the bone by the agency of the granulations. The bone at a very slight depth underneath is found, in most cases of healthy inflammation, of the ordinary consistence of cancellous tissue, which it resembles in structure even in those parts which ought to be compact. In strumous caries, on the contrary, the osscous structure will be found softened and otherwise altered, as will be described when treating of struma in bone; and it is to this combination of strumous inflammation of the body of a bone with ulceration of its surface, that the old descriptions of caries appear to be intended to apply. The ulcerated surface in healthy inflammation is superficially excavated, much softened, and easily broken down by the pressure of a probe. The interior of carious bone is softened by inflammation, its cancelli enlarged, and filled with the products of the softening and disintegration which has been going on around them. These products, as has been noticed above, are principally oil-globules, blood, and other débris of the soft tissues, and granular inorganic materials, having the same chemical composition as the salts of the bone. The soft parts almost always take part in the morbid actions which lead to caries, and abscesses are formed which burst externally, and leave sinuses communicating more or less directly with the softened bone, and through which some part of its exposed surface can generally be felt with the probe. Abscesses, however, frequently form in the neighbourhood of inflamed bones without any actual communication with them. This is, perhaps, more peculiarly the case in childhood, and near the joints.

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* A preparation in St. George's Hospital museum illustrates this accident. The operation was given up. After the patient's death, it was found that the abscess lay not half an inch from the track of the trephine.

Symptoms. The symptoms of caries are merely those of inflammation *plus* an abscess exposing softened bone; hence all that has been said about the frequent obscurity of the early stages of ostitis will apply to caries, and with greater force, inasmuch as these ulcerative actions are more prone to occur in the course of low inflammations. Constant pain, then, in the neighbourhood of a bone, with swelling and more or less loss of the function of the part, followed by abscess which will not heal, indicate usually that the abscess proceeds from ulceration of a bone; and this presumption is much strengthened if the pus have a putrefied, offensive odour, and a prominent mass of granulations project from the sinus, and is converted into certainty if fragments of bone can be found in the discharge, or if the communication with the bone is sufficiently direct to allow of its being struck with a probe. When carious bone is touched by the probe, it is not usually found particularly sensitive, perhaps is not sensitive at all; it bleeds readily; its surface is irregular, and may generally be felt to be soft. When the opening is sinuous and the bone cannot therefore be struck, the diagnosis can be, of course, only inferential, and founded mainly on the persistence of the symptoms. Chemical analysis of the pus may also sometimes assist the diagnosis, since the pus from diseased bone contains more phosphate of lime than that from soft parts.* Sometimes the patient's sensations afford valuable evidence, more particularly in caries from healthy inflammation, where striking lightly over the carious part often causes the same kind of sharp pain as is felt when a carious tooth is struck.

Caries is generally accompanied by more or less of plastic or organisable effusion in the bone in the neighbourhood of the ulcerated spot, leading to condensation of the deeper parts of the bone, and to periosteal deposit of bone on the surface. This, however, is the case only in those instances where the process partakes of the healthy or sthenic character. In those low inflammations which are usually called strumous, whether connected with obvious deposit of tubercle or not, such thickening, or periosteal deposit, is often absent; but the bone is softened throughout all the affected portion, the disintegration becoming less and less perceptible at a distance from the part where the loss of substance exists. The deposit around ulcerated bone frequently leads to ankylosis of the less movable joints; an occurrence which is extremely common in the tarsus.

In cases of superficial ulceration of bone, the agents for its removal are either the periosteum, when that membrane remains entire, or the granulations which spring from inflamed surrounding parts when the periosteum has been removed.† Other cases, however, of ulceration are met with, in which the disease is more deeply seated, and commences in inflammation of the membrane lining the cancelli or medullary cavity, and where, therefore, the agents for the removal of the bone are to be sought in the vessels of this membrane. Such cases as these are very rare. I am able to refer to preparations showing the reality of the affection,‡ but I have no knowledge of the special symptoms which it presents, or the indications, if any, which it furnishes. It is evident that, shut up as the inflamed parts are in the interior of the bone, the products of inflammation can find no exit, and the disease must soon become merged in one involving more extensive destruction, *i. e.* in diffused suppuration or internal necrosis.

A question is very frequently asked as to whether caries or ulceration in bone be a curable affection or not. To this only one answer can be given: viz. that no ulcerative, *i. e.* destructive, process is ever curable, in the widest sense of that term, since some defect will always remain; but that ulceration in bone, like ulceration in soft parts, may terminate in cicatrisation, or the reproduction of an inferior kind of bone which is less vascular, and less smooth and well formed than the portion which it replaces. This fortunate termination becomes less probable, the deeper the disintegration of the bone extends, and the more profound is the constitutional cachexia with which it is associated. In extensive strumous caries it is hopeless.

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* Bransby Cooper, *Lectures on Surgery;* Barwell, *On Diseases of the Joints*, 1861, p. 238.

† See *Packer's Malgaigne*, p. 106, for the appearances of a bone undergoing absorption by granulation for the removal of a sequestrum after compound fracture.

‡ St. Bartholomew's Hosp. series i. no. 163.

The *treatment* of bone affected with this form of inflammation is a matter of great importance; since upon the success or failure of such treatment, the preservation of the bone, and with it sometimes of the limb, or even the life of the patient, may depend. Ulceration in bone does not differ materially from the same process in soft parts, except in the far greater length of time which it usually occupies. In the bone, as in soft parts, the powers of nature will in most cases suffice for cure, when cure is possible, if the parts be put in a suitable position, kept at rest, and preserved clean and free from the accumulation of the discharges. But often the patient cannot wait for the completion of this natural process, and calls upon the Surgeon to deliver him from the chronic malady which has become insupportable. Or, sometimes his health gives way under the protracted discharge; or, after an interval of quiescence, the caries again makes progress, and threatens to involve neighbouring bones, and to impair the functions of the whole limb, if not arrested. This is more peculiarly the case in the tarsus, and other "irregular" bones. In the ordinary treatment, then, of caries, no other local measures are required than to provide a free exit for the discharges, and to keep the exposed surface of bone clean. The appropriate constitutional treatment will complete all that art can do to promote recovery, and more active surgical interference is not only useless but hurtful, as it risks doing harm without a reasonable prospect of doing much good. Incisions, however, should not be spared to the utmost extent necessary to keep the discharge free, or perhaps even somewhat beyond this limit. In fact, in all the acuter cases of ostitis, much benefit appears to follow the mere division of the tense structures over the bone. When the surface can be felt exposed and carious, it is still more necessary to have a free discharge; since otherwise, the pus, being confined, may burrow beneath the periosteum, and extend the mischief to the neighbouring parts of the bone.*

Often after this free exposure of the carious bone, the disease will gradually subside; but when this is not the case, the question occurs, whether it will be proper to attempt to remove the carious surface and expose a more healthy one, either by rasping or gouging the bone, or by the application of the actual cautery; or to modify the diseased action by injections, or by applications to the carious part. The injections which are in use are composed either of iodine or dilute muriatic acid. The latter is intended to unite with the base of the phosphatic salts of the bone, and thus to remove its surface by disintegrating successive portions of it. It has been tried, and is strongly recommended by M. Chassaignac;† and no objection appears to exist to its employment in suitable cases; but I cannot say that I have found much benefit from its use. The injection of tincture of iodine in the treatment of abscess depending on disease of inaccessible portions of bone (as in psoas and lumbar abscess), has been warmly extolled by M. Boinet.‡ This practice does not seem to have been much followed in England, notwithstanding the encouraging results of M. Boinet's experience; but M. Robert, who has tested these results by numerous trials, pronounces (what indeed theoretical reasoning would have led us to expect) that M. Boinet "has singularly over-estimated the good effects of iodine,"§ and states his belief that the iodine is quite incapable of modifying the diseased action in the bone. At the same time, he allows that this remedy is very useful in large abscesses depending upon carious bone, from its effect in correcting the fetidity of the pus, which is so liable to occur, and which is so detrimental to the patient's health, by the foul atmosphere in which it compels him to exist. The iodine has also the effect of consolidating and corrugating the walls of the abscess, so as to prevent its extension, and promote its conversion into a direct sinus. This is a considerable advantage in such cases. From the few trials that I have had the opportunity of making, I believe that M. Robert's estimate of this treatment is very near the truth. The iodine may be used diluted at first, with one or two parts of water; and afterwards the pure tincture (Lond. Phar.) may be used. It is better at first to withdraw as much of the injection as will run out, and cover the opening with a poultice. Numerous injections will be necessary.

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* Some authors teach that pus exercises a solvent power upon the bony tissue itself. This doctrine appears unsupported by direct evidence; and it seems improbable that the bone can be so dissolved while it retains its vitality.

† *Mém. de la Société de Chirurgie*, loc. cit. ‡ Ibid. vol. ii. p. 454.

§ Robert, *Conférences de Clinique Chirurgicale*, Paris, 1860, p. 208.

In cases of superficial caries of bones which can be exposed without too much injury to the soft parts (of which the tibia and calcaneum are the most familiar examples), it may sometimes be advisable to rasp or gouge away the carious surface of the bone, and endeavour to arrest the further progress of the disease by the application of the actual cautery or strong nitric acid to the surface so exposed; or, if the disease be very superficial, the latter measures may be sufficient, without any preliminary removal of bone. These operations should, however, only be performed in cases of evident necessity. We have only too frequent instances of the dangers of all operations on bone, especially of such as involve the exposure of large surfaces of the cancellous tissue, as is generally the case in these gouging or rasping proceedings, which are extremely apt to be followed by diffused inflammation of the interior of the bone (osteomyelitis) and by pyæmia. Still, if the disease be accompanied with much pain and loss of motion, and the wound show no tendency to heal, the patient is often compelled to have something done for his cure, as otherwise he would lose his means of livelihood; or the Surgeon may think it right to interfere in order to arrest the progress of the disease into neighbouring organs. The decision of such questions as these must, of course, be left to individual judgment.

The application of the actual cautery appears to be less dangerous than the cutting operation, and is often successful in superficial caries. It seems less in use than might be expected, considering the many cases of caries limited to one, and that a superficial, bone of the tarsus and metatarsus, which are seen, especially in children. Here, however, and in all situations where a bone can be removed without prejudice to the function of the part, excision is so much more satisfactory when any large part of the bone is involved, that it is, perhaps, not wonderful that the less radical measures are not much in use.

M. Sédillot has lately proposed a more extensive use of the operation of scooping or gouging carious bone, as a substitute for excision or amputation.* His plan contemplates the removal, by the gouge, of the whole bone except a shell of the outer healthy parts, which is left to effect the restoration of the bone. With all due respect for the authority of M. Sédillot, it seems impossible to allow that such a proposal is either useful or safe. There are few cases of extensive and deep-seated caries in which the limits of the disease can be ascertained, and a partial operation is often worse than none at all. Besides, extensive exposure of the interior of a bone is a most hazardous proceeding, and only too often terminates in pyæmia. M. Sédillot, however, is said to have performed his operation thirteen times without any instance of such complication. The further consideration of this question will occupy a portion of the essay on EXCISIONS.

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* See *Lancet*, Dec. 10, 1859.

Ulceration in bone is not always of this chronic nature. Mr. Stanley has described* some cases of "phagedænic ulceration" of bone which seems to have been connected with the occurrence of rodent or canceroid ulcer† in the soft parts; and in diseases more distinctly partaking of the nature of cancer the bones may be destroyed with great rapidity; but here the affection in the bones is only a part of the general disease, and its treatment must depend on the view which may be taken of the latter. Cases of rapidly spreading ulceration do, however, occur, in which the bone alone is affected. Two remarkable instances have been put on record by Mr. Cæsar Hawkins;‡ in one of which the disease was only part of a general strumous affection, but peculiar on account of its extreme rapidity and great extent. The other was a very remarkable instance of removal of great part of the skull-cap, and protrusion of the brain through the opening so left; but without the formation of pus. An abscess was found in the brain, but this was connected with violence done to the protruded portion of that organ, and not with the disease in the bones. No distinct proof of the presence of any constitutional cachexia was obtained, nor was the exciting cause of the complaint apparent. Its inflammatory nature was testified by distinct marks both of inflammatory thickening and of inflammatory erosion on the bone in the neighbourhood. Therefore the old definition of ulceration as "absorption from inflammation" would strictly apply to this extraordinary case; and we have already seen (see p. 616) that the formation of pus, though an ordinary, is not an absolutely necessary, feature in ulceration of bone; but it is rarely indeed that so large a portion of bone is removed without the formation of abscess, especially when compact tissue is involved; for the instances of removal of inflamed bone without suppuration, hitherto noted, have occurred almost exclusively in thick cancellous bones, such as the vertebræ and tarsus.

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* *On Diseases of the Bones*, p. 65.

† See vol. i. p. 210.

‡ *Med.-Chir. Trans.* vol. xxxix. p. 285.

Necrosis, or the death of some considerable portion of a bone, occurs as the consequence of any cause which sufficiently impedes the circulation in the neighbourhood. This is precisely analogous to what takes place in the gangrene of soft parts; and as in gangrene the non-vascular parts are most easily affected, and then those which, though vascular, are furthest from the centre of the circulation, and in which the vessels are fewest and smallest, so the frequent occurrence of necrosis of bone is, no doubt, due to the comparatively small quantity of blood which circulates in that tissue, as well as to the inextensible nature of the osseous substance itself, in consequence of which any extravasation or product of inflammation causes pressure directly upon the blood-vessels, or narrowing of the channels for the conveyance of the nutritive plasma.

It is denied by some authors of reputation on this subject that necrosis is ever a consequence of inflammation of bone,* and they refer the disease always to periostitis or osteomyelitis as its cause. But this appears an error in two senses. In the first place, there is no essential difference between periostitis, or osteomyelitis, and inflammation of bone. The diseases so called are only inflammations in which the part of bone alone affected, or, as is much more common, the part *most* affected, is the external table or the medullary tissue. In the second place, the disease properly called ostitis very frequently induces necrosis, not indeed usually of the inflamed part, but of the parts in its neighbourhood. The inflamed part itself does not usually perish, because the final cause of necrosis is the stoppage of the circulation by the obstruction or obliteration of the vascular channels, while the first effect of inflammation is the enlargement of those channels. When the ostitis has reached the stage of exudation, the dilated vascular channels become again narrowed; but the process takes places slowly, and organisation, which involves the formation of new vessels, takes place in the exuded material as it is produced. Still, although the event is not a common one, traces of inflammation are seen on sequestra sufficiently often to show that the inflamed part does sometimes die. The same causes, in fact, which produce gangrene in soft parts will occasion the death of a bone; and among them inflammation holds a high place, less on account of its direct effect, *i. e.* its tendency to produce the death of the part inflamed, than of its indirect consequences, whereby the circulation around the inflamed part is obstructed, and so necrosis of the neighbouring parts is induced. Hence in the course of an extensive caries the circulation of some considerable portion of the bone is apt to be destroyed, and then a necrosed or loose piece is found in the middle of the ulcerated part. Such combination of necrosis with caries was called by the old writers dry caries or hard caries.

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* Gerdy, *Maladies des Organes du Mouvement*, 1855, p. 217.

Another very frequent, if it be not the most common, cause of superficial necrosis is the denudation or separation of the periosteum, which occurs as a consequence either of direct injury or of effusion between it and the bone. It is true that large separations, and even extensive destruction, of the periosteum may occur without the death of any portion of the bone, and this is indeed common in the bones of the head and face; but the peculiar circulation in the former, and the great vascularity of all parts in the latter region, sufficiently explain this fact. In other parts, it is the more general rule that when the periosteum is destroyed or separated over any considerable portion of a bone, the superficial layers of the latter will perish. This is one reason, among many, why it is important to adjust the soft parts over a bone denuded by violence, in order that they may rapidly adhere to it, and that so fresh vessels may connect the periosteum to the bone before the latter has undergone an irremediable change.

Violence, acting directly upon the bone, is another very frequent cause of necrosis, as is frequently seen in compound fracture, where both the periosteum and the medullary tissue are much damaged, and the bone dies without any proof of previous inflammation having existed.

The action of cold is often exhibited on the bones as on the soft parts, and the subject will be found treated of under the head of Frost-bite (vol. i. p. 191). In deep burns the bones are also occasionally charred, and they are frequently involved in gangrene of the superficial tissues, from whatever cause it arises. Certain caustic applications are well known as frequent causes of necrosis, of which the superficial exfoliation produced on the surface of the jaw for the cure of epulis is a familiar example. To this category belongs also the necrosis of the jaw which is produced by exposure to the fumes of phosphorus.* The various constitutional cachexiæ, especially syphilis and struma, are frequent causes of necrosis; but here the affection of the bones is only a variety of the inflammatory process.

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* This affection will be found treated of in the essay on Surgical Diseases of the Teeth and Gums.

The abuse, and even occasionally the moderate use, of mercury is another cause of necrosis. It is quite true that many of the preparations and cases entitled "necrosis from the abuse of mercury" may be explained, as having been cases of syphilitic necrosis, in which mercury had merely failed to arrest the disease, and had had nothing to do with causing it; but there are too many instances on record of the occurrence of necrosis of the jaw, during the administration of mercury for some disease which has no influence upon the bones, to admit of a doubt that the affection was directly induced by the so-called remedy. Thus, in the museum of Guy's Hospital (no. 1091) is a sequestrum, consisting of two-thirds of the alveolar process of the lower jaw, which is said to be "necrosis induced by the use of mercury for ovarian dropsy." Unfortunately it appears that what is a moderate use of mercury in one person is equivalent in rare cases of idiosyncrasy to an excessive abuse, so that no practical rule can be laid down; but it is at any rate proper to remember this occasional effect of mercury, particularly when prescribing it for cachectic persons. In the museum of St. Bartholomew's Hospital is a preparation, in which necrosis of the jaw is attributed to the administration of a few grains of mercury during a fever; but in some fevers necrosis has been frequently observed as a consequence of mere lowering, as it would seem, of the vital powers, without any mercurial cachexia.*

It would be idle to attempt an enumeration of all the causes which may lead to the death of bone. The above are the most common, and will be found sufficient for practice. The symptoms and treatment are identical in most of these forms. Some will require special notice hereafter.

When a portion of bone is to die,† the first phenomenon is the cessation of circulation in it. This leaves it hard, white, and sonorous when struck. It does not bleed when exposed or cut into, and is insensible. Occasionally, when the dead bone is exposed to the air, and acted on by the presence of putrid pus, its colour becomes nearly or quite black; large surfaces of hard, black, necrosed bone are sometimes left exposed by the sloughing of the skin over the tibia. The dead bone at first retains its connexion to the bone around, as well as to the periosteum, or whatever part of the nutritious membrane may belong to it; but the presence of a dead part is never long tolerated by the living tissues, and accordingly the processes which are to eliminate it soon become perceptible on both these structures. The periosteum, or medullary membrane, as the case may be, separates from the dead bone and becomes inflamed, a quantity of ossific deposit (more or less, according to various circumstances) is poured out between it and the dead bone, and this deposit soon becomes converted into new bone, forming a sheath over the dead portion, by which the latter is enclosed, or *invaginated*, as the technical term is. The dead part is now called a *sequestrum*, a name only properly applied to it when loose and invaginated, though often incorrectly used of any piece of dead bone. While this sheath is being formed from the membrane coating the dead bone, changes are going on in the living bone to which it was attached. When the latter has been previously diseased (*i. e.* when the necrosis has been of inflammatory origin), the inflammatory deposit which surrounds the sequestrum softens, pus is formed, and a groove of ulceration is produced at the expense of the circle of inflamed bone which forms the margin of the sequestrum. If the surrounding bone have been previously healthy, the sequestrum acts as an irritant upon it, setting up, first inflammation and thickening to a variable distance, and then ulceration. Thus a groove is traced around the sequestrum; and the formation of this groove is accompanied by suppuration, as has been described above (see p. 619). The pus formed in the neighbourhood of the dead parts makes its way to the nearest surface, and in so doing interrupts the formation of the periosteal sheath, leaving sinuses, or *cloacæ*, passing through this sheath from the sequestrum to the surface of the body, or sometimes into a neighbouring joint or serous cavity. The presence of such sinuses, leading through the shell of bone to hard, smooth, sonorous bone at the bottom of the cavity, is the distinguishing mark of necrosis.

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* See, in the museum of St. George's Hospital, series ii. nos. 91, 95, preparations in which both the jaw and the clavicle became necrosed in the same patient during the course of a fever.

† This description refers to the process as it occurs in bone previously healthy.

The formation of the groove between the dead and living bone is a very slow process in the bones of the limbs, requiring generally many months for its completion. It is impossible to lay down any rule as to the time at which a sequestrum may be expected to be found separated from the rest of the bone. In animals, as has been proved by experiments,* the process may be completed in a few days. In children it seems to go on sometimes with great rapidity, especially in the bones of the face. On the other hand, instances are not wanting in which half a lifetime may have elapsed, and the process still remain unfinished. One of these has furnished a preparation in the museum of St. Bartholomew's Hospital.* It is the section of the shaft of a femur, exhibiting in its interior a small fistulous cavity, with necrosis of a small portion of the inner layers of its wall. A groove extends to some depth between the dead and the contiguous living bone. The limb was removed by amputation. The femur had been fractured thiry-five years previous to the amputation: the fracture was followed by abscess in the soft parts, and the formation of a fistulous passage leading into the interior of the bone, which passage remained open during the whole period from the fracture to the removal of the limb. It may, however, be stated generally, that the more superficial the dead portion is, and the more freely it is exposed, and the more violent the action of the cause has been, the more rapidly will it separate (see p. 626).

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* Troja, *De novorum Ossium Regeneratione*, exp. i.

When the groove is completed, the dead bone is loose in the cavity so formed for it, and quite free from any vital connexion to the body. The sequestrum, therefore, is now eliminated, and this may be regarded as the natural process of cure, since it prevents the extension of the necrosis further into the bone; but as the sequestrum is still lodged in its cavity in the interior of the bone, it thus becomes an abiding source of life-long irritation, which must by all means be removed as speedily as possible.

The above is intended for a sketch of the process of necrosis in one of its most frequent seats, viz. the outer (subperiosteal) layers of the compact sheath of a long bone; but it may occur in any situation,—in the medullary canal, or central layers of the compact tissue, in flat or irregular bones, or the spongy ends of long bones; or again, the extent of the necrosis, or the situation of the part, may modify considerably the process of separation, *i.e.* the surgical aspect of the case. For example, even when necrosis is subperiosteal, and the process of separation normal, it may be in a part from which extraction is impossible, as on the inner surface of the skull, spine, pelvis, thorax, &c. The subperiosteal sheath is often wanting in the bones of the limbs when the soft parts have been extensively destroyed over the affected bone; and it is never formed in the skull, where necrosis is so common, nor in the cancellous bones, where, though less common, the disease is by no means rare.

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* Series i. no. 176.

In such cases, when the dead bone is loosened from the living, it comes away of itself, or can be at once removed. Such a piece of dead bone, not confined by an invaginating sheath of new bone, is called an *exfoliation*. Again, it sometimes happens that the necrosed portion involves the whole thickness of the shaft of a long bone, and sometimes the whole length of its diaphysis; some instances even are exhibited in the museums where the epiphysis also has shared the destruction, though this is very rare.*

Each of these conditions is accompanied by noticeable peculiarities. When the whole thickness of the shaft is involved, especially in a bone, like the humerus, enjoying free and rapid motion, fracture is likely to follow on the completion of the groove, although this result may be obviated by the strength of the case of new bone. When the whole diaphysis is involved, the case assumes a graver aspect, since the extent of inflammation which is necessary for the formation of the new shaft, and the great suppuration thereby produced, suspends, or perhaps permanently abolishes, the functions of the limb. The muscles become matted together, the skin œdematous and penetrated by numerous sinuses, the parts below incapable of extended motion or energetic action; cases even are on record where the inflammation, having reached the great vessels, has produced coagulation of the blood in both artery and vein, and consequent dry gangrene of the limb.† In other cases either the ulceration around a sequestrum, or other disease of the bone, involves a large vessel, or the point of an exfoliating portion of bone is driven into the artery in some movement of the limb;‡ and thus either a direct wound of the artery is produced (when the sinus of the diseased bone communicates with the laceration in the artery), or if no opening exists externally, a consecutive aneurism may possibly be established. In any case of such injury to the main vessels, when the diagnosis can be properly established, amputation would be indicated in the lower limb. In the upper limb the main arteries are separated from the bone by a mass of soft parts; and smaller vessels would hardly complicate the case, as they might be included in the incisions required to expose the diseased bone. In other situations attempts must be made to tie the ulcerated vessel; and if they fail, as they generally will, from the rotten condition of the parts, the trunk leading to it must be secured.

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* Guy's Hospital Museum, no. 1160^{30}, necrosis of the condyles and shaft of the femur, and upper end of the tibia. See also no. 1160^{218}, referred to farther on.

† Museum of St. Bartholomew's Hospital, series i. no. 134.

‡ Mr. Poland, in his essay on Rupture of the Popliteal Artery, quotes one case of spontaneous hæmorrhage from that vessel in necrosis of the femur (a patient of Dr. Porter, *Dublin Journ.* vol. v.), and two others where the artery was wounded by a sequestrum during active movements of the limb (Dr. Byron's case, *Med.-Chir. Rev.* vol. xxiv. p. 259; Dr. Jacob's *Diss. Med.-Chir. de Aneurism.* Edin., 1814). I have seen fatal hæmorrhage from the lingual artery in disease of the jaw, and from the aorta in caries of the spine. Mr. Stanley (op. cit. p. 111) relates a case in which the capsule of the knee-joint was penetrated by the pointed end of the necrosed shaft of the femur.

In cases of necrosis involving the whole thickness of a bone (*total* necrosis), when the seat of the disease is a large bone, such as the femur, life is in considerable danger; and as the patients are usually persons in whom some constitutional cachexia is present, and probably in an advanced stage, they frequently succumb.* Still the dangers of amputation in these cases are so great, and the advantages of saving the limb so decided, that they are usually left to the reparative powers of nature. In small bones, such as the phalanges, amputation is indicated. In the upper limb large portions of the whole thickness of the shaft may be removed with entire success, and preservation of the motions of the extremity. In a subsequent essay the indications for excision of the whole or parts of bones on account of necrosis, involving their whole thickness, will be further considered.

Central necrosis is usually an obscure complaint, and is hardly distinguishable by its symptoms from chronic abscess of the bone. In fact, as their symptoms are the same, so the same treatment is applicable to each of them. Deep-seated pain, throbbing, loss of rest, general debility, perhaps rigors and typhoid fever, with slight puffiness over the seat of the disease, and a little pain on pressure; these symptoms persisting for a considerable period without relief, notwithstanding that the appropriate constitutional and local remedies have been employed, indicate the necessity of making an exploratory incision at the seat of the inflammation, and, if the surface be found healthy, of removing it with the trephine in order to search for an abscess or sequestrum in the centre.

Deep-seated necrosis often leads to suppuration, making its way to a free surface. This is very common in the long bones, and is a frequent cause of abscess and destructive inflammation of the joints. Necrosis may also attack a portion of the articular surface of one of the great joints of the body, although this is rare except as a complication of extensive strumous affection of the joint-surface. Limited necrosis of articular ends is, however, occasionally met with, and, like the previous affection, will set up abscess in the joint. The diagnosis of these causes of articular abscess must be sought in the essay on DISEASES OF THE JOINTS, and the indication for operative treatment in that on EXCISION.

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* An interesting case of total necrosis of the shaft and upper part of the femur in a young subject, æt. 13, in whom amputation was successfully performed a year and half after the commencement of the disease, is recorded by Mr. Kerr of Aberdeen in the *Ed. Med. and Surg. Jour.* 1834, vol. xlii. p. 98. It is worth perusing, as showing the activity of repair at that early age.

In the flat bones, where they are formed of compact issue, necrosis is an exceedingly common disease; but here, as has been before observed, the dead bone will usually exfoliate without invagination. The same may be said of the necrosed portions of irregular bones, which consist almost entirely of cancellous tissue (such as those of the tarsus), in which necrosis is by no means rare. Whole bones, or large portions of entire bones, of the tarsus, and sometimes, but less often, of the carpus, are found quite separate from all their attachments, and merely retained as foreign bodies among the soft parts. In such cases there is sometimes a little difficulty in making the diagnosis; since the dead bone has not the hard ringing sensation usual in necrosis of compact tissue, and the large size of the necrosed piece sometimes prevents it from moving under the probe. The case, therefore, simulates one of caries. This difficulty was experienced in the case of a little child under the writer's care in whom a sinus existed leading down upon the os calcis. The probe passed down to soft bone, not in the least movable, and crumbly to the touch. On the soft parts, however, being turned back, it was found that the posterior part of the calcaneum, involving at least half the bone, was dead and quite separated from the anterior part. This having been removed, the child made a rapid recovery. I have seen similar cases in childhood repeatedly, and more especially about the tarsus. However, though the cancellous tissue is sometimes affected with necrosis, it should be remembered that this is exceptional, and that necrosis is an affection more peculiarly of the compact tissue, and especially of the densest bones. Thus the petrous bone is frequently necrosed, and has been known to exfoliate almost entire.*

Treatment. Hitherto we have been considering the usual method of separation; and as this is a long and tedious process, seldom completed under many months in the case of a large sequestrum, and often dating by years, it is not surprising that efforts should have been constantly made to anticipate the period of cure by accelerating the separation of the diseased bone. These, however, have resulted in disappointment. The process must be left to find its natural completion in the spontaneous separation of the dead bone from the living; and any attempt to effect this by art, *i. e.* to detach the necrosed portion, and to cut it away from the living parts, only extends the area of the disease, and endangers the preservation of the limb. Special considerations, applicable to some regions of the body, such as the skull, may indeed induce a Surgeon to operate on necrosed bone before it is loose, for the relief of matter pent up below it: such operations, however, are not undertaken with a view of curing the diseased bone, but of restoring the function of organs secondarily affected.

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* *Path. Soc. Trans.* vol. vii. p. 335. A similar case occurred lately at St. George's Hospital under Mr. Prescott Hewett's care; Museum, St. George's Hospital, series ii. 99.

But when the sequestrum has separated and lies loose and invaginated in new bone, surgical interference is most necessary. There is perhaps no part of Surgery in which the improvements effected in comparatively modern times have done so much to preserve life and limb, and to obviate pain, as in the treatment of necrosis. The invaginated portion of bone can never get out by any natural process: the very completeness and efficacy of the efforts which nature makes to preserve the continuity of the bone, and to restore its strength, effectually imprison the dead portion. Small pieces or granules of dead bone constantly exfoliate from carious surfaces; but when the sequestrum is of any considerable size, the cloacæ are never so large as to admit of the escape of the sequestrum through them, although sometimes they are very nearly large enough. Thus, in the museum of St. Bartholomew's Hospital, there is a curious specimen,* in which a small piece of loose bone, just too large to get out of any of the numerous cloacæ which have formed around it, is found rattling about in its cavity as if in a dice-box.

The requisite operation consists in cutting down on the dead bone, and exposing it sufficiently to remove it. If the necrosis be superficial, nothing is required beyond turning back the soft parts, which have no connexion with the dead bone, elevating the latter, and pulling it out with a pair of forceps. But, for the removal of an invaginated sequestrum, it is necessary to open the sheath by enlarging one of the cloacæ with the trephine, or cutting forceps, until it is large enough to admit of the extraction of the piece. Sometimes, when the sequestrum involves a large portion of the shaft of the bone, it may be found impossible to get the piece away until a pair of cutting forceps has been introduced through the enlarged aperture, and the dead bone divided. In the necrosis which so often attacks stumps after amputation, a ring-like piece may separate from the end of the divided bone. Its extraction is then a matter of considerable difficulty; but still, as there is a free opening on to the extremity of the dead bone, it may be accomplished with some little trouble. If a similar sequestrum should form on one of the long bones, involving a ferule-like portion of its surface, its removal would be still more troublesome, requiring free incisions on both sides of the limb: but I am not aware that such cases have been noticed in practice. A preparation in the museum of St. George's Hospital (series ii. 75) shows a strip of necrosed bone winding spirally, for a considerable distance, round the shaft of the humerus.

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* Subseries A, no. 94.

It has sometimes been made a question whether the sequestra of necrosed bone can be removed by a gradual process of disorganisation and molecular decay. If this question be proposed as an essay in scientific pathology, there is no doubt of its great interest; but viewed as a practical consideration in Surgery, hardly any value attaches to it. Experiments on animals certainly appear to show the possibility of the removal of small pieces of excised bone re-implanted in the excision-wound;* and it is possible that, in the human subject, sequestra of bone may be to some extent eaten away by a process of absorption like that which sometimes removes the ivory pegs driven into bones for the cure of ununited fracture;† but even allowing all upon this head which any one could reasonably deduce from such facts as these, we should still be justified in saying that the process is so slow, so uncertain, and so partial, that no account ought to be taken of it in Surgery.‡

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* Heine, in *Gräfe und Walther's Journal*, Bd. xxiv. p. 527, quoted by Wagner, op. infra cit. p. 146.

† See vol. i. p. 805.

‡ It may reasonably be doubted, also, whether the absorption said to have occurred in some of the experiments above referred to did really take place, or whether the whole thing was not a mistake on the part of the experimenters. Gulliver's experiments (*Med.-Chir. Trans.* vol. xxi.) show that portions of loose bone, thrust into the tissues of living animals, may remain an indefinite time without experiencing any absorption, as proved by careful weighing at the beginning and end of the experiment. Again, cases such as that quoted on p. 644, prove that a portion of bone, of no extraordinary size, may remain necrosed during a great part of a lifetime, and suffer no perceptible diminution in size, even when its mechanical connexion with the rest of the body is not entirely destroyed. But surely when loose and separated from the body it must be still less under the influence of the vital actions.

It is therefore necessary, in every case in which a sequestrum forms, that a surgical operation should be undertaken for its removal. The word *sequestrum* is here used in its strict sense, to express a portion of dead bone contained in a case of new bone. An *exfoliating* portion of bone may separate and be thrown off by the natural processes, though it is usually necessary to facilitate its removal when loose by incisions.

A question is sometimes raised, whether it is prudent to operate as soon as the operation is possible, *i. e.* as soon as the bone is loose, or whether a certain time should not rather be given, in order that the newly-formed bone may become consolidated, and the limb sufficiently strong to perform its functions. The question, however, is rather fanciful than practical. No harm appears ever to result from taking away a loose piece of bone, but much mischief often follows on its being allowed to remain. If, in rare cases, the bone is left too weak to bear the weight of the body or the motions of the limb, it is probable that this is a consequence, either of such extensive destruction of periosteum as finally to preclude reproduction, or of some constitutional fault, or other predisposing cause. The inflammation excited by the presence of the sequestrum in the neighbouring bone has probably not passed the stage of softening; while, from the same low rate of the morbid processes, the bony deposit furnished by the periosteum has been small in quantity and low in organisation. In such a case as this it would appear that the best chance for restoring to the bone its proper density would be afforded by the operation which would relieve it of the cause of the inflammation whereby its cohesive power is being destroyed. It would, therefore, be far more rational to remove the dead bone, and put the limb at rest, than to leave the source of irritation, and expect a cessation of the effect from perpetuation of the cause. It is not always easy to determine the question, whether the bone is loose or not, since the growth of the periosteal sheath, or even the shape of the loose portion, and the arrangement of the parts around it, may prevent it from moving under the probe. Of this fact an instance has been given above (p. 647), and the reader may consult a clinical lecture recently published by Mr. H. Smith, *Medical Times and Gazette*, March 22d, 1862. In cases, therefore, where the disease has lasted so long that the separation may be reasonably expected to be complete, it is right to endeavour to remove the bone, even although the probe has not given decisive evidence that the operation can be carried out.

It is necessary here to say something respecting the agents, and the manner, of regeneration of bone after loss of substance from necrosis. In doing this, however, it would be impossible, in an essay of this sort, to go into the question with any approach to completeness; but it is hoped that enough will be found in the following paragraphs to illustrate the points necessary for practice. The student who wishes to learn more about the matter is referred to the works of Troja, Weidmann, Flourens, Syme, and Wagner.

The most important agent in reproducing bone lost by necrosis is, without doubt, the periosteum; and this membrane is sufficient of itself to replace all the ordinary exfoliations and partial necroses which follow injuries, &c. The osteogenic properties of the periosteum, when in contact with the bone, have long been known, in fact must have been apparent when the function of the membrane was first studied; and that periosteum, when separated from the surface of the bone, will still generate new bone, is no very novel discovery, since John Bell seems to have been perfectly acquainted with the fact, and describes the formation of a bony cyst by secretion from the detached periosteum, around a collection of blood which had dissected off that membrane from the bone;* and the experiments of Syme and Stanley are well known. Lately the osteogenic powers of periosteum have been placed in a very striking light by the experiments of M. Ollier of Lyons.† He has shown that, in rabbits, portions of periosteum may be entirely detached from the bone, and pushed into the cellular tissue of the limb, or even grafted into remote parts of the body, or into the body of another rabbit, and that bone would be generated from the fragment of periosteum in this novel position. He has even succeeded in producing bone by such grafting of portions of periosteum kept for more than an hour out of the body.

It is far from certain, nay, it is most improbable, that any such results could be produced in man, since the conditions of all reproductions, and especially of reproduction of bone, are known to differ so much in man and animals; but, even if the vitality and osteogenic power of the periosteum be less in the human subject than in the lower animals, still it seems reasonable to infer, from observed phenomena, that that power is of the same nature; so that these striking experiments may serve to fix more firmly on the attention of Surgeons the importance of preserving the periosteum in cases where the reproduction of lost bones is in question. This property of periosteum may also have some application in Plastic Surgery; but the only such application with which I am acquainted hitherto is the proposal by Mr. Jordan for the cure of ununited fracture by means of a plastic operation beneath the periosteum (noticed in vol. i. p. 804), the success of which appears doubtful. In all cases, then, where loss of substance in bone has taken place, or where the bone seems deprived of life, it is of the greatest importance that the periosteum should be preserved; so that, in excising carious or necrosed bones, great care should be taken to make the incisions well down to the bone which is to be removed, and to keep the knife close to it, that the periosteum may, if possible, be left behind.

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* *The Principles of Surgery*, by John Bell; a new edition, by Charles Bell, 1826, vol. iv. p. 406. The pathology of the case, as related by the author, is sufficiently obscure; but the case may be used to show that Bell knew that bone could be formed from the detached periosteum.

† *British Medical Journal*, 1860, pp. 398, 438. I may mention that some of M. Ollier's experiments have been repeated and verified by numerous experimenters, amongst others by myself.

It has frequently been made a question, on what this power of reproduction depends, whether on the action of the fibrous membrane itself, or on the detachment, together with its lower strata, of small particles from the surface of the bone, which serve as nuclei, around which new bone grows. It is not easy to prove that such nuclei are not detached in every case; but there is no evidence that such is the fact. Bone has often been known to be produced from portions of periosteum which had been previously carefully examined, and no such particles found; while in other cases it has appeared probable that the periosteum had carried fragments of bone away with it. M. Ollier considers that a "subperiosteal blastema" exists naturally between the periosteum and bone, and that this is the source of the deposit.

The periosteum, however, although the most important, is not the sole agent in the reproduction of bone; so that it may be confidently expected that bone will be reproduced in healthy subjects, even though the periosteum be extensively destroyed; but the reproduction will not be so complete as if that membrane had been left. Such a process of reproduction may often be watched in cases where the soft parts have sloughed after scalp-wounds, and have left the cranium exposed.* The accident will often be followed by exfoliation from the surface of the bone; granulations then shoot up from the bony surface so exposed, and these are joined by others which advance from the soft parts in the neighbourhood: a fibrous cicatrix is formed, which can be felt gradually hardening and ossifying. If an opportunity occurs for examining it after the lapse of some considerable time (say half a year), it will be found that the fibrous tissue of the cicatrix is ossifying at its deepest part, and scattered granules of bone will probably be met with at various parts of the cicatrix.

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* See Wagner *on Repair after Resection of Bones* (New Syd. Soc.), Appendix, p. 241, for a case in which this form of reproduction is well described.

This process may go on even when the bone and periosteum have been removed by operation, as in the wounds of resection,* but is much more active when previous inflammation has been excited in the medullary tissue and surrounding soft parts, during the action necessary in order to eject a piece of necrosed bone. In fact, speaking generally, the process of reproduction after necrosis is beyond comparison more active than after injury or operation. Thus, when necrosis has preceded the operation, whole bones of the fore-arm have been removed, and yet a useful limb has been preserved. In a case which I had lately an opportunity of seeing, in which Mr. Savory removed the entire shaft of the radius on account of necrosis, leaving the articular ends,† the bone had grown from each of these ends to so great an extent, that in eight months after the operation there remained an interval of only an inch and a half, and this appeared to be gradually, though slowly, contracting. This and several similar cases will be found quoted in Wagner's treatise above referred to, and may serve as an encouragement for boldness in our attempts to save limbs after extensive necrosis.

The exfoliation of diseased portions of bone, such, for example, as takes place so frequently in the course of extensive strumous disease, when a portion of the ulcerated surface is cut off from the rest, and therefore perishes, is not generally accompanied by any of that reparative effort which forms part of the process in a more healthy condition. The mere presence of necrosis in such affections is of comparatively little importance; possibly the removal of the dead part may be advisable (but only if it can be done without much violence), but the operation cannot be expected to cure the disease, since the necrosis is not its cause, but its effect. Nevertheless considerable improvement may, in appropriate cases, be expected to follow on the removal of the dead portion, which must always act as an irritant; and the exposure of the carious surface is also very frequently the starting-point of a more healthy action. Hence, when bone is felt exposed and dead, it is usually advisable to endeavour to remove it, even although the surface around it is known to be carious.

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* See Wagner, op. cit. p. 156.

† Ibid. p. 243.

The above description applies to necrosis in its more usual form. But besides this common chronic form of the disease, an affection which deserves the name of *acute necrosis* is sometimes, though not very often, met with. The destruction of all the soft parts surrounding a small bone, as a phalanx in acute neglected whitlow, will of course lead to the exfoliation of the whole of it, and to this affection the name of acute necrosis is sometimes given. There is nothing, however, in the pathology or treatment of such a disease to call special attention to the bone. The rapid and tensive inflammation threatens other parts of equal importance,—the joint, the tendons, nay in some cases even the skin,—with destruction; and the free evacuation of the products of the inflammation is the only measure from which any good can rationally be expected. But there is a less-known class of cases in which larger bones are involved in rapid destruction, without known cause, or from causes apparently quite inadequate; and such cases involve not merely local mischief, but very grave danger to life. Many such cases of rapid necrosis are the result of that diffuse inflammation of the periosteum which has been described above; but in others which I have had an opportunity of seeing, I have failed to detect such a cause for the death of the bone, or indeed any cause to which so extensive and so universal an action could reasonably be ascribed. Such a case was the following: a stableman was admitted into St. George's Hospital on account of disease in one foot. The history was obscure, but it seemed certain that little more than three weeks before his death the foot was comparatively well, as it was to an injury supposed to have been received two days before his admission, in running violently down the stable-yard, that the disease was attributed. There was œdema, swelling, and pain over the dorsum of the foot; and this condition was attributed to diffuse cellular inflammation, and treated by superficial incisions, which did not penetrate the periosteum. The man died, with symptoms of pyæmia, but no secondary abscess, twenty days after his admission. On examining the foot, all the tarsal bones were found loose, and grating on each other like stones in a bag; the cartilages between them had almost entirely disappeared. On section, the bones were of a dark-gray hue, and some slight trace of pus was seen here and there in their interior, but no such distinct indication of inflammation of the lining membrane of the cancelli as to deserve the name of osteomyelitis; nor was the periosteum thickened, vascular, or separated from the surface of the bone by either lymph or pus in any appreciable quantity. The surfaces of the bones exposed by the removal of the articular cartilages were ulcerated, but not deeply. The bones were of their natural consistence.

Is such an affection as this amenable to any treatment? This seems doubtful, if it be conceded that cases of acute necrosis really exist in which the affection is different from diffuse periostitis. In the latter affection timely incisions may succeed, as has been already said, in checking the effusion and restoring the nutrition of the bone; but if the whole bony tissue be involved at once, what agency can be reasonably expected to restore it to health? It is clear that the main question in such a case is, whether the patient's powers will endure the strain of the disease, so that the bone may be cast off, and he may have the chance of its reproduction, or whether amputation will give him a better prospect of life. But the prognosis of an amputation undertaken under such circumstances would be in the highest degree unfavourable, since the condition of system in which such grave results can follow from such trivial injuries, leaves little prospect of bearing up against so serious an injury as the removal of a limb; and the tendency to pyæmia is so strong, that it is impossible to say that that condition of the system may not be actually present, though latent, when the operation is done. It will, therefore, in most cases, be judged better to support the patient's strength by a liberal allowance of tonics and opiates until the graver dangers have passed away; and then, if the usefulness of the limb is hopelessly destroyed, to remove it when the patient has rallied from the typhoid condition in which the disease commences. Incisions may not have the power of averting the death of the bone, but they ought to be made to an extent sufficient to liberate all tension, and that for two principal reasons—partly in order to avoid sloughing of the periosteum, and consequent destruction of the nidus in which the new bone is to be formed; partly to provide a ready way for the pus, which must form, to escape, and for the examination of the bone and its eventual extraction.

Constitutional Affections.

Scrofula in bone. There are two forms in which scrofulous affections of bone are met with: viz. either a deposit of tubercle, or a low inflammation of the osseous substance; and there is good reason for considering the former as a consequence, or effect, of the latter. Let us, then, first consider the peculiar or distinctive characters of scrofulous inflammation of bone.

A scrofulous bone, when examined in the early stage of the disease, is soft, light, and oily; sometimes more highly charged with blood than natural, and occasionally (though only rarely) presenting a deposit of tubercle in its interior. Bones in this condition are constantly met with after the removal of scrofulous joints: the substance of the bone is easily cut with a knife, and the cancelli are large, and charged with a red jelly-like mass of débris. The inflammation readily passes into ulceration, or caries, and the bone then exhibits on its surface a number of minute pits, or depressions, from each of which the ulceration extends, so as to communicate with those around, until an extensive worm-eaten surface is exposed, soft and rotten on its exterior, bleeding readily, and giving exit to a foul-smelling ichorous pus, in which pieces of decomposed bone can be felt, as gritty particles under the fingers. The periosteum becomes detached and thickened, and is gradually converted in a gelatinous mass of granulations.

The minute changes in the ultimate tissue have been ably described by Dr. Black, in a series of researches to which my own observations lead me to assent. The cancelli are dilated, and they, as well as the lacunæ and canaliculi, are filled with exudation. Occasionally, minute projections of bone from the walls of the cancelli indicate an attempt at the reproduction of bone, and that healing by sclerosis which has been already described as one of the usual events of healthy inflammation. The leading features, then, of the pathological anatomy of strumous inflammation are the same as those of ostitis in general; and the only distinctive anatomical peculiarity consists in the nature of the exudation, which chokes up the canals of the bone. Dr. Black has given several analyses, tending to establish these four conclusions: that tuberculosis gives rise (1) to a considerable increase of fat in the diseased bone; (2) to a large diminution of the salts of lime; (3) to a diminution of the organic matrix; (4) to an increase in the soluble salts. For the details of the analyses, the reader must be referred to the original treatise.* They serve to illustrate the fact, that strumous is distinguished from common inflammation by the softness, lightness, and oiliness of the affected bone; to which may be added, the greater extent of diffusion of the morbid changes.

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* *On the Pathology of Tuberculous Bone*, Edinb. 1859, p. 32.

The superficial caries, during the mere presence of which, the bone, if the affection be not very extensive, is possibly still in a curable state, spreads gradually inwards, and then the condition of the bone passes beyond the possibility of repair. Large abscesses form, and the whole cancellous extremity, or the whole bone if it be one of the cuboid bones of the tarsus or carpus, is converted into a cavity bounded by a thin shell of osseous matter, and containing bony substance, either in mere débris, or so soft that it will crumble away in maceration. These abscesses are seldom accompanied by that thickening of their walls from periosteal deposit which takes place in simple ostitis; still, at some distance from the seat of profuse suppuration, fresh deposit is sometimes found thickening the bone, or producing ankylosis in joints which enjoy little motion. Necrosed portions of larger or smaller size are often found, but no "sequestra" in the proper sense of that term, as signifying necrosed portions invaginated by new bone.

Such are the anatomical characters of scrofulous inflammation of bone. The other common development of that diathesis in the osseous system consists in the deposit of tubercle, either circumscribed or diffused. Circumscribed tubercle (much the rarer form) seems most common in the skull, deposited on the outside of the bone beneath the periosteum (the strumous node); and next to this its favourite locality is in the cancelli of the joint-end of some bone, generally the tibia. No inconvenience seems to be produced by such tubercle till it softens; and then, if situated in the articular end of a bone, it usually makes a passage into the neighbouring joint and destroys it; if on the skull, the softening of such a tubercle forms a cachectic abscess difficult to heal, bordered by indurated cellular tissue, with cold, bluish edges, and leading to exposed and roughened bone, which, however, has not the peculiar feeling of necrosis, and is not at first dead, although it is liable to become so. The deposit of diffused tubercle is more common in the shafts of the long bones. It fills up the cancelli, appearing as a nodulated, or granular, yellowish mass of soft consistence, and extends frequently along the whole length of the shaft. My own impression is, that this diffused tubercle less frequently and less rapidly softens than the circumscribed; but exact information on this point is wanting. It should be remembered that when the shaft is attacked by this or any other form of disease, the extremities usually escape, and vice versâ,—a matter of great importance in the treatment of diseases of the joints.

It has occurred to me, though hitherto only on two occasions, to meet with a peculiar form of ulceration, which was in one case certainly,* and in the other probably, connected with scrofula. Numerous pits were found on the articular surface, varying in depth, but confined to the epiphysis, with sharp edges, and curdy purulent contents. Their openings into the cavity of the joint were cleanly punched out of the cartilage, and all the cartilage around was quite healthy. A few small granules of bone were met with among the contents of the cavities. In one of the cases, when the bones were examined, there were found several spots of vascular and softened tissue beneath the surface of the bones, evidently the commencement of similar pits. There was no trace of tubercle. The thigh was amputated, and the patient recovered for a time, but soon died of phthisis. In the other case, the patient, a boy under the care of Mr. Thomas Smith, recovered after excision of the knee, and remains in good health. I believe this pitting or spotted ulceration of the articular ends of bones to be one of the forms of scrofulous disease, and to be indistinguishable from its other forms before dissection. It presents a very favourable condition for resection, from the strict limitation of the disease to a very slight depth below the surface.

Symptoms. Of the symptoms of scrofula in bone little need be said here. The general symptoms of the diathesis, added to an indolent swelling of some bone, lead to a diagnosis not to be mistaken. The swelling is composed partly of the engorged soft tissues, and partly occasioned by real enlargement of the bone. The colour is usually white and pasty,† and the swelling indolent; but sometimes, when the inflammation is higher than common, and suppuration imminent, redness and pain may be present. When suppuration has been effected, the pain generally subsides, and the functions of the part are more or less completely regained, even when the bone is destroyed to a considerable extent.

Treatment. The treatment of scrofula in bone offers little that is peculiar. For local treatment, perhaps the most important indication is to keep the part at rest during the prevalence of inflammation by splints and bandages. Local depletion should be cautiously used while there is pain, tenderness, and superficial redness, or the part may be enveloped in a large warm poultice or fomentation. When inflammation is not apparent in the soft parts, but there are signs of its presence in the bone, it will be necessary to use counter-irritation by caustics or blisters; or in less severe and more chronic cases by means of the tincture of iodine, or other stimulating application. When irritation has subsided, pressure by means of strapping will be found very serviceable, both in insuring rest and in promoting absorption, and the local action of mercury (Scott's bandage) may be combined with this. By these simple measures, with judicious constitutional treatment, most of the cases of strumous inflammation, which are seen before the occurrence of suppuration, will be brought to a favourable issue.

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* A notice of this case will be found in *Path. Soc. Trans.* vol. x. p. 217.

† The "white swelling" of old authors was named from strumous disease of the joints, though many other affections came to be included under the term.

When suppuration is once established, it is better to procure exit for it by small incisions, and to use every precaution to prevent the denudation of fresh portions of bone. The question, however, of the early or late opening of abscesses connected with strumous bone is one on which a good deal of difference of opinion very naturally exists, and which is best determined in each individual case. If such abscesses are allowed to go on increasing, the soft parts may be extensively undermined, the disease may extend to fresh bones, and an opening may form in a disadvantageous situation. If opened early, the cavity may be attacked with inflammation, which, if the abscess be large, may even prove fatal. If, however, the abscess be near an important organ, as a joint or serous cavity, there can be no doubt that no time should be lost in evacuating it. Large openings should be avoided; but the introduction of a piece of lint, or a drainage-tube, will keep the discharge flowing; or the abscess may be emptied by means of a trocar from time to time, and the access of air thus effectually precluded. When the bone is exposed through the opening of an abscess, its condition should be thoroughly investigated, once for all, with the probe, in order to judge of the necessity for operative interference; but nothing is more mischievous than repeated meddling with diseased bone. The general indications for operations upon bones affected with strumous caries, and the form of operation indicated, will be the same as in caries depending upon other causes; but the prognosis will be less favourable than when the constitution is unaffected, and therefore operations should be undertaken with more caution. Operations on these cases will usually succeed or fail according as scrofula has attacked the viscera or no, and according to the extent of its diffusion through the system; but even after a successful operation the patient is by no means secure against a relapse in some other part.

For the general treatment the reader must be referred to the essay on SCROFULA.

Syphilitic affections of bone. The chief phenomena of the syphilitic affections of bone have been already spoken of summarily under the head of tertiary syphilis (vol. i. p. 443); it will therefore only be necessary here to go a little more into detail as to the anatomy of bone affected by syphilis, and the means by which the disease is to be diagnosed. As the general treatment of syphilis has been laid down in Mr. Lee's essay, only the local treatment of its manifestations in the osseous system will be dwelt on here.

Syphilitic affections are those in which the existence of a chronic limited inflammation of the periosteum alone is most clearly proved, if, indeed, such inflammation be not peculiar to syphilis. Strumous nodes (as we have just remarked, p. 657) are formed by scrofulous matter confined between the carious bone and its periosteum, and are due to an affection of the bone; but the true node, that which follows syphilis, is caused by the effusion of lymph between the bone and periosteum, and is due to inflammation of a limited portion of the deeper layers ("subperiosteal blastema") of the latter. Hence it is of a different signification from that of a strumous abscess; for while the latter is merely a consequence of diseased bone, and necessarily involves corresponding loss of substance and the slow processes by which alone an ulcer (and more especially a strumous ulcer) in bone can be healed, the syphilitic node is itself the starting-point of the disease in the bone, and if early and properly treated, the whole organ can be restored in a short time to a state of health. But although in a node the inflammation is usually limited to the periosteum, it is not always so. Numerous preparations show thickening of the substance of the bone beneath nodes,* proving the implication of the deeper structures, and therefore a state of disease which, though still curable, may be expected to be more obstinate than mere periosteal effusion; and if the skull be examined in the situation of a node, some roughening of its outer table may generally, perhaps always, be discovered. The progress of nodes, when they are not absorbed under appropriate treatment, is in one of two directions: either the subperiosteal effusion ossifies, or it softens and gives rise to caries, accompanied usually by suppuration. The former event is commoner on the tibia, the latter on the skull. The indisposition of the pericranium to form new bone is a very well-known fact in pathology, nor am I aware that the formation of new bone in syphilitic nodes of the skull has ever been proved, though new bone may be sometimes found deposited on the outer table of the skull in the neighbourhood of large ulcers;* in nodes of other flat bones also, ossification, if it occurs, is rare. Many nodes appear so hard as to be pronounced osseous; but the feeling is often deceptive, since the tense and thickened periosteum raised by semi-solid effusion gives a sensation hardly to be distinguished from that of a bony swelling. Therefore, in a hard node which is of no long standing, treatment for its removal may be confidently recommended, and all the more if the swelling be situated on a flat bone. On the tibiæ nodes are prone to ossify, and then the deeper ossified part remains as a permanent irregularity on the surface of the bone; but the unossified portion may often be dispersed by appropriate measures. When a node softens, and the question occurs whether pus has formed, the case ought to be carefully examined, in order if possible to determine the point. The principal indication of the presence of pus is the shining, tense, and thinned condition of the skin. It is important to obviate more destruction of the skin than is inevitable on the bursting of the abscess, since such sores are very difficult to heal, and in some cases appear incurable. The best way is to make a very small puncture, and close it after drawing off the pus. Frequently, under the proper treatment, the soft parts will adhere again to the bone with very slight or no exfoliation.† But in most cases the formation of periosteal abscess after a node is followed by the exfoliation of most of the subjacent bone. Syphilitic nodes are usually preceded, and always accompanied, by more or less of dull aching pain in the bone, especially liable to exacerbations at night; or this "syphilitic rheumatism," as it is sometimes called (the *douleurs ostéocopes* of French authors), may be the only symptom referred to the osseous system during the progress of the secondary affection. Mr. Parker‡ is inclined to refer the pain to a syphilitic inflammation of the medullary membrane.

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* St. Thomas's Hospital Museum, series c, no. 54.

When the syphilitic cachexia is further advanced, the whole bone or a great part of it may be diseased through its entire thickness, leading to chronic ostitis, and terminating in sclerosis, or what is sometimes called "hypertrophy" of the whole thickness of the bone.

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* Even here it is in most cases doubtful whether the deposit has been formed outside the skull, or whether the thickening is not produced by deposit within the diploe expanding the outer table; for deposit in the diploe is exceedingly common. See below on the "tuberculated" form of syphilitic ulceration in bone.

† See Parker, *Modern Treatment of Syphilitic Diseases*, 4th ed. 1860, p. 291.

‡ Loc. cit..

I am not aware of any distinction which could be drawn between such instances of chronic inflammation and those arising from non-specific causes, except that which is founded on the presence of concomitant and preceding syphilitic symptoms in other organs.

Still more grave and more obstinate developments of tertiary syphilis in the bones are those carious and necrotic affections (ulcerative or gangrenous) which so often attack the skull, the bones of the face, and the superficial long bones, in persons much reduced by excesses or by the injudicious administration of mercury. In former times, under the horrible system which prevailed in the "foul wards" of the great hospitals, where every person labouring under any disease supposed to be caused by promiscuous intercourse was compelled to take mercury to salivation, the ravages of syphilis on the bones were dreadful; and it is to this system that we owe many of the preparations of syphilitic caries and necrosis preserved in our museums. But there seems no reasonable doubt that such affections do also occur in persons who have never taken mercury,* especially when the disease has been allowed to go on unchecked, and the constitution is at the same time enfeebled by alternations of debauchery and hardship, as is the case sometimes with sailors, and more frequently with prostitutes.

The diagnosis of syphilitic affections is usually easy from the history of infection and the presence of other symptoms; but it may in some cases be obscured by the patient's unwillingness or inability to reveal the history of the original disease. Thus the pains in the bones may be referred to rheumatism; but here the diagnosis can in most cases be easily established by observing that rheumatic pains in the bones are generally accompanied by affections of the thick fibrous structures (muscles or fasciæ) and of the joints; or, if the rheumatic affection be more acute, the urine and sweat will probably furnish indications of the nature of the disease. When nodes have made their appearance, the diagnosis is usually easy, the only question lying between syphilis and struma, since rheumatic periostitis is, as we shall see, more diffused. In the absence of history, the concomitant symptoms will guide us while the skin is unbroken; and after pus has made its way to the surface, some assistance may be derived from the nature of the secretion. Syphilitic caries and necrosis (as has been observed in the essay on SYPHILIS) are not primary affections of the bones, but are the result and termination of nodes, or of inflammation of the bones, or of ulcerative affections of the soft parts around the bone, as in the palate, and therefore have been preceded by a long course of symptoms, during which the diagnosis is usually established. If not, it rarely presents any difficulty, since the traces or the presence of other symptoms of constitutional syphilis can hardly fail to be recognised.

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* See Parker, op. cit. p. 281.

An interesting comparison has been made between the forms of syphilitic ulceration in bone and those of syphilitic eruption on the skin. Specimens of rounded ulcers may sometimes be met with, especially on the skull-cap, which bear a strong resemblance to the rupial ulcers so frequent in an advanced stage of constitutional syphilis.* A small round spot of ulceration is seen, where the surface of the bone is worm-eaten from the presence of numerous minute depressions, and in some cases the bone around this worm-eaten central portion is marked by arborescent grooves, the traces of increased vascularity. Later on, a circular trench is marked around the worm-eaten spot; and as this widens and deepens, it undermines and finally chisels out the piece, which separates as a sequestrum, and then the bone scars over, leaving a rounded depression, much larger than the original spot, the surface of which is rather glazed and a little vascular, and the bone below it a good deal hardened. In well-marked specimens, these *annular* ulcers, as they are termed by Mr. Paget,† look very characteristic; but in less advanced cases, especially before the surrounding trench has formed, or again at a late period when cicatrisation has obliterated some of the more distinctive characters of the ulcer, it seems impossible to distinguish it from a scrofulous or other lesion. The other characteristic form of syphilitic ulceration is the *tuberculated*, which appears to commence by a tubercular thickening of the external wall of the bone, recalling the syphilitic tubercle so common on the skin of the face, &c., and due not to periosteal deposit, but to chronic inflammation of the compact tissue itself. This inflamed bone soon becomes dotted over with numerous little pits or depressions, which coalesce and form ulcers, usually oval or round, penetrating deeply into the interior of the bone. Besides these, Mr. Paget has described a third form of syphilitic ulceration, the *reticulated*, in which the disease appears first to show itself in the form of a network of periosteal deposit, which is liable to perforation by ulcers subsequently forming and assuming the annular type, of which latter, therefore, the above may be regarded as a variety. Of the two kinds of syphilitic ulcer, the annular appears to me the more characteristic; but I do not believe that either is so distinctive of the disease as to enable us, with any thing like certainty, to infer the previous constitutional affection from examination of the affected bone; nay, I have known pathologists of the greatest experience refuted in such attempts by the subsequent discovery of the history of the preparation.

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* Museum of St. Bartholomew's Hospital, sub-series A, nos. 63, 109.

† In the Catalogue of the Museum of St. Bartholomew's Hospital and in that of the Royal College of Surgeons.

Any of these forms of syphilitic ulceration may affect the bone so deeply as to penetrate its whole thickness. Thus in the museum of St. Bartholomew's Hospital is a specimen (A 34) of a clavicle in which the bone has given way (probably after death) in consequence of penetrating ulceration attributed to syphilis. Spontaneous fracture of a long bone, however, from penetration by a syphilitic ulcer is extremely rare; while penetration of a flat bone, especially of the cranium, is still a pretty frequent circumstance, and used to be an ordinary result of syphilis. In the greater number of such cases no serious mischief follows; the dura mater is exposed on the separation of the necrosed central part of the ulcer, but soon gets covered over, so that its pulsations are no longer visible, and in a little while the gap will be filled up by fibrous tissue. In rare cases, however, pressure upon the brain is produced either by matter confined between the skull and dura mater, or by ulceration laying open a branch of the middle meningeal artery and causing hæmorrhage.

Treatment. The treatment of constitutional syphilis has been already described, and it has been shown that at one period or other of the disease a prolonged and sufficient exhibition of mercury will be necessary for cure. To this general rule the affections of bone form no exception, for although some of them are usually found accompanied by so profound a cachexia, so complete a prostration of the whole system, that mercury is inadmissible, it will also be found that such affections do not admit of cure. Iodide of potassium often acts, however, upon the earlier affections of the bone and periosteum like a charm, and the symptoms soon disappear; but those whose experience in the treatment of syphilis is most extensive* believe that the improvement is not permanent, and that for the entire eradication of the constitutional affection a mild but prolonged course of mercury (for which the calomel vapour-bath is the most appropriate agent) ought to be insisted on. The local treatment of bone inflamed from syphilis presents several interesting questions. Nodes will usually be benefited by blisters, or, if the bone seem to be more deeply affected, by the persevering use of mercurial ointment, strapping with the empl. hydr. cum ammoniaco, iodine paint, &c. But when the pain in the inflamed bone is constant and very distressing, it is quite justifiable to divide the periosteum by a free incision; and then, if nothing is found to account for the tension and to hold out a prospect of its relief, a trephine may be applied to the bone itself, and its medullary canal laid open.* If symptoms of cerebral disturbance make their appearance in the course of ulceration of the cranium, the application of the trephine has sometimes been successful in preserving life; but, on the other hand, it is not to be denied that it has sometimes produced or hastened death. The proverbial obscurity of all cranial affections ought, I think, to make us cautious in adopting so extreme a measure as trephining the skull, unless in a patient whose state is otherwise evidently hopeless. Epileptic convulsions, even with slight symptoms of paralysis, are hardly a sufficient indication for the operation; but the experience of Mr. H. Lee† has shown that in some cases the removal of the diseased bone has been followed by the healing of ulcers which had previously been obstinate; and it seems that the removal of the outer table only, when it is dead, and appears to be keeping up irritation, is a safe practice.

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* Parker, op. cit. p. 289.

The treatment of fissures and defects of the palate from syphilitic necrosis will be found discussed in a subsequent essay.

Rheumatic and gouty affections of bone. It is extremely difficult to be certain of the existence of any specific affection of bone due to the rheumatic diathesis. Rokitansky, in his "attempt to determine the characters of the constitutional affections of bone, particularly the inflammations and caries, by reference especially to the appearance of the bone after maceration,"‡ doubts "whether rheumatism gives rise to an inflammation that can be distinguished by any definite character of its products, or to any particular caries, however positively assertions be made on the point;" but there is no doubt that common ostitis is very generally produced by exposure to cold and wet, and other causes, which at the same time generate rheumatism; nor is there any reason whatever for questioning the universal opinion of persons of experience, that those who are the subjects of rheumatism are also those who are most prone to inflammation of the superficial bones, such as the skull, tibia, &c.

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* See vol. i. p. 443; Parker, op. cit. p. 283.

† *Proceedings of the Med.-Chir. Soc.* vol. iii. p. 283.

‡ Op. cit. vol. iii. p. 202.

The disease now commonly called "chronic rheumatic arthritis" is regarded by some authors of credit as originally a disease of the bone. In this work, however, it is considered as commencing in the soft tissues of the joint (see DISEASES OF THE JOINTS).

I would not be understood, however, to deny the existence of an affection which deserves to be called "rheumatic ostitis." The condition of the articulating extremities of the bones in cases of chronic rheumatic arthritis is very peculiar, and can hardly be explained by any theory except that of some constitutional peculiarity in the disease, since neither the age of the patient nor the mode of causation of the malady offer any constant features which can account for the singularity of the affection of the bone. That which is most characteristic in all those cases which appear to be rheumatic, is their very slow course, and the great length of time during which inflammation may be present without either caries or necrosis. In all rheumatic affections of the joints, and in many of those of the limbs, although it may be true that the complaint originates in the fibrous tissues, yet the bones will become involved if the disease lasts long enough; and in that case the principal features will be in the shaft of a long bone, extensive stalactitic or foliaceous laminated deposit from the periosteum, and sclerosis of the superficial portions of the bone; the medullary canal and the deep cancellous tissue being usually, if not always, unaffected. In the museum of the Royal College of Surgeons, Mr. Paget has classed some specimens* as "rheumatic ulceration," in which, along with these appearances on the shaft of the bone, ulceration is seen invading the newly-formed periosteal deposit; but whether this is a natural, though unusual, result of the constitutional disease, or an accidental complication, seems doubtful. In any case, the occurrence of nodes, and more or less of inflammation of the wall of superficial bones in cases of rheumatism, is a sufficiently probable event; but it is a complication which must be treated on general principles. The nodes do not affect the limited extent and rounded outline of those due to syphilis, but are irregular swellings of the periosteum, involving a considerable extent of the surface, and probably some of the thickness of the bone.

The most characteristic effects of rheumatism, however, are displayed upon the articulating extremities; but as this disease will be found fully described in the essay on DISEASES OF THE JOINTS, it will not be necessary to say much about it here.

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* Nos. 626, 627, 627 A.

The chief features which are distinctive of rheumatic inflammation of the bones are, the extensive deposit of bone in the fibrous structures around, the condensation and thinning of the shell of the bone, the rarefaction and partial absorption of its interior, and the consequent change of shape which parts containing much cancellous tissue, such as the articular heads and necks of long bones, suffer. In the articular disease the new bone is found, to a great extent, in the ligaments and other tissues distinct from the periosteum, and thus forms what Dr. Adams calls "additamentary bones," which have been so often mistaken for portions fractured off the bony prominences near which they may be situated and ununited. I shall adduce some reasons for believing that many of the specimens in which portions of bone have been found near the shafts of long bones, but movable upon them, and which have been thought to be instances in which exostoses had been fractured at their base, may be of the same nature.

As to the treatment of the rheumatic affections of bone, nothing need be said here, since all that is necessary to add to the general treatment of ostitis will be found in the essay on DISEASES OF THE JOINTS.

I have nothing to say about the affections of the bones in gout. The deposit of lithate of soda is sometimes found in the interior of the bones in inveterate cases, as well as on their exterior; but its importance is quite secondary. Stromeyer* alludes to a case in which nearly all the bones of one side of the body were hypertrophied in a patient who had long suffered from gout; but no opportunity occurred of examining the bones affected.

Mollities ossium. The peculiar condition of the bones which is known by the name of mollities ossium, or malacosteon, is one which is very rarely met with. In the female pelvis, as a cause of difficulty in parturition, it is less rare than under other circumstances, and demands the special attention of the obstetric Surgeon, involving, as it does, some of the gravest questions which are to be solved by that branch of our art. These questions, however, which have reference to the altered relations between the deformed bones of the pelvis and their contents (especially the gravid uterus and fœtus), are not within the scope of the present work. We have only to consider the disease in its pathology and general surgical bearings.

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* *Handbuch d. Chirurgie*, vol. i. p. 442.

The pathology of mollities is far from being satisfactorily established; and there can be little doubt that this has arisen, in great part at any rate, from the fact that authors have confounded several different conditions under the same name. Some, indeed, make no distinction between mollities and fragilitas ossium; while others regard mollities as an affection allied to, if not identical with, rickets.

The disease which appears best to deserve a separate description under the name of mollities, is marked by the following characteristics. Several bones are usually affected at the same time. The portions of bone attacked are uniformly softened throughout the whole extent of the disease. The disease, however, does not in all cases affect either the whole length or the whole thickness of the bone, and if the specimen be examined at an early period, the outer shell is often found to retain its natural consistence.* When the whole bone is affected, it can be readily bent, and resembles, in extreme cases, as Dr. Ormerod† remarks, rather a portion of fatty matter enclosed in a case of periosteum than a bone. If the cancellous tissue (in which the disease appears to originate) be examined, it is found that the cells are enlarged, sometimes to such an extent that the whole bone is expanded, and are filled with a peculiar reddish gelatiniform matter, in which, on microscopical examination, much fat and oil can be discovered, together with blood-discs. Besides these (which are the common products of any degenerative change), certain peculiar nucleolated nuclear bodies have been described by Mr. Dalrymple.‡ Instances of bones affected with mollities do, however, occur, in which the amount of fat is not greatly increased. Thus in a specimen in Guy's Hospital Museum (no. 1004^{88}), taken from a case reported by Mr. Solly, in the 27th vol. of the *Med.-Chir. Trans.*, it is said that the diseased tissue consisted simply of an organic matrix, with little earthy matter, and containing little fat. Cases like these show that it is impossible to describe mollities as simply a fatty degeneration. Degeneration of some sort is, however, always present; and as this advances, it involves the compact walls of the bone, and then the disease becomes for the first time recognisable, by the symptoms which will be immediately described. At a later period, the whole bone is found to be involved, and becomes a mere bag of soft matter enclosed in the periosteum, which, perhaps, may be somewhat thickened, but it does not appear that any further destruction of the bone itself occurs. It is merely converted into a soft, generally oily, material, which crumbles away on maceration, but which seems capable of resisting absorption for an unlimited period during life.

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* As in Dalrymple's case, referred to below.

† *Brit. Med. Journal*, Sept. 10, 1859.

‡ *Dublin Quarterly Journal*, 1846, p. 85; see also *Path. Soc. Trans.* 1846-7, p. 148.

The symptoms of mollities are sufficiently striking in a well-marked case to attract immediate notice, however obscure may be the real nature of the constitutional affection. The patients are, it is said, usually females,* and generally past the middle period of life. Repeated pregnancy appears to act as an exciting cause of the disease, and may, perhaps, account for the greater proportion of females.

The disease appears to be, in some cases at least, hereditary. Thus, in the history of Dr. Ormerod's patient, referred to above, it is stated that both the son and daughter were subjects of the same affection. Sometimes pain is complained of in the affected bones for some time before the nature of the disease becomes manifest; in other cases, however, the deformity induced by gradual softening of the bones is the first symptom noticed. When this softening has proceeded far enough, the bone gives way gradually, if it has been equably and thoroughly softened, so as to yield and become merely deformed; but if the softening has been confined to the internal part of the bone, and the thin outer shell has been left solid, and therefore brittle, spontaneous fracture (or, more correctly speaking, fracture from very slight causes) is liable to occur. The former class of cases, in which the bone bends without breaking, are those in which mollities is most characteristically marked, since spontaneous fracture preceded by pain in the bone is also a feature of malignant and other diseases of the osseous system. In such extreme cases of mollities, the limbs become distorted in the strangest way, so that the thighs have been known to bend till one of the feet touched the head; and from the softening of the vertebral column and bending of the limbs, the stature is very considerably diminished. The constitutional cachexia is often not very strongly marked, and patients will live in this condition for an indefinite period, bedridden from the weakness of their limbs, and the loss of the firm points from and to which the muscles act, but with sufficient mental and constitutional vigour. The cause of death appears generally to be simple exhaustion; or failure of vital powers, like what takes place in extreme old age (in fact some of these patients do not die till the extreme of life);[*] or sometimes functional disturbance, induced by the altered relations of the viscera, and the pressure to which, from various causes, they are subjected. Not unfrequently, however, the patient does not die of the disease at all, but, having lived under its influence for many years, is carried off by some totally different complaint.[†]

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* I do not find quite so great a disproportion between the sexes as is implied in the descriptions given by some authors. Of ten cases of true mollities taken at random, six were females, and four males.

With these symptoms it is not surprising that this disease should have been claimed as merely a rarer form of several better-known affections of bone, to all of which it bears some resemblance, however little they may seem to bear to each other. Some authors[‡] consider mollities to be merely fatty degeneration, or atrophy of bone; others regard it as rickets attacking the adult; while many class it with cancer. Now each of these opinions has a basis of probability, and it is very possible that many of the cases of so-called mollities might with greater propriety have been entitled "atrophy" of the bone. Of this Mr. Curling's case appears to have been a good instance; and the difficulty which some authors have expressed in distinguishing between mollities and fragilitas ossium[§] appears to have arisen from their having compared together cases in which there was no real difference, and where the name mollities had been given to simple atrophy.

The connexion between rickets and mollities appears, at first sight, a very close one, on account of the bending of the bones, and liability to fracture from slight causes, which characterise both. Some patients, also affected with undoubted mollities, have suffered in their youth from rickets.[||] Still, if we consider the question attentively, the differences between the two affections far exceed their resemblances. Rickets is an affection of early life, closely allied to scrofula in its causation and in its cure; it is peculiarly amenable to treatment; and under favourable circumstances the constitutional cachexia, which is its essence, readily disappears as the child grows. Mollities hardly ever makes its first appearance till after middle life; and, even in those cases where the patient has been rickety, not till long after the cachexia of that disease has subsided; it shows no alliance with scrofula, and is not amenable either to the remedies for that disease, or, as far as is known, to any other remedies, but pursues its career steadily, unaffected for good by any medical treatment.

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[*] See the cases mentioned in the Catalogue of Guy's Hospital Museum, nos. 1044^{62}, 1098^{50}.

[†] Thus in Dr. Ramsbotham's case (*Path. Soc. Trans.* 1846-7, p. 148) the patient died of pneumonia, after suffering for more than six years from mollities.

[‡] See Mr. Curling's paper in *Med.-Chir. Trans.* vol. xx. p. 356.

[§] It would be well if the term fragilitas ossium were allowed to become obsolete, since it only describes a symptom common to several affections.

[||] This was the case with Dr. Ormerod's patient, above referred to.

In the latter particular, as in several of its other features, it bears a far stronger resemblance to cancer. In fact there can be little hesitation in classing some specimens preserved in museums as mollities under the head of diffused cancer; and, conversely, in recorded cases of cancer, some of the bones have been found in a state closely resembling, if not identical with, mollities. Thus in a case of secondary cancer in the spine and other parts, after removal of scirrhus of the breast, related by Mr. Cæsar Hawkins,[*] it is noted that "the centre of the neck appeared a little sunk forward, as if the upper vertebræ had been depressed in that position;" and the anatomy of the affected bone is thus described: "The body of the fifth cervical vertebra was very irregular on its surface, and was softened throughout, with much enlargement of the cells of the cancelli, which were filled with a sanguineous pulpy fluid; the two adjoining vertebræ showed a lesser degree of the same morbid structure."

But, allowing that many of the recorded cases of mollities may be referred to simple atrophy, and some of the others to cancer, there can still be no doubt of the existence of an independent disease to which that name is peculiarly appropriate. In one such case recorded by Dr. Bence Jones,[†] the leading feature was the peculiar condition of the urine. This attracted attention, together with the state of the patient's general health, long before any alteration in the bones was apparent; in fact no alteration in them was discovered till after death. The peculiar substance contained in the urine appears to have been closely allied to albumen. Dr. Bence Jones's conclusions on this subject may be quoted here: "66·97 parts of this hydrated deutoxide of albumen were passing out of the body in every 1000 parts of urine. Hence, therefore, there was as much of this peculiar albuminous substance in the urine as there is of ordinary albumen in healthy blood. So far, then, as the albumen is concerned, each ounce of urine passed was equivalent to an ounce of blood lost. The peculiar characteristic of this hydrated deutoxide of albumen was its solubility in boiling water, and the precipitate with nitric acid being dissolved by heat, and re-formed when cold. By this reaction a similar substance in small quantity may be detected in pus, and in the secretion from the vesiculæ seminales. This substance must be again looked for in acute cases of mollities ossium. The reddening of the urine on the addition of nitric acid might perhaps lead to the re-discovery of it; when found, the presence of chlorine in the urine, of which there was a suspicion in the above case, should be a special subject of investigation, as it may lead not only to the explanation of the formation of this substance, but to the comprehension of the nature of the disease which affects the bones."

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[*] *Med.-Chir. Trans.* vol. xxiv. p. 45. See also a case of cancer of the bones after scirrhus of the breast, described by the author in *Path. Soc. Trans.* vol. xi. p. 219, in which some of the ribs were perfectly flexible. In examining a case of well-marked cancer of the pelvis, I have found a condition of the innominate bone bearing an almost equally close resemblance to mollities.

[†] *Phil. Trans.* vol. lxvi. p. 55. This is the same case as Mr. Dalrymple's, already referred to,—the paper in the *Philosophical Transactions* containing the account of the peculiar substance found in the urine.

These cases, then, of what we may call true mollities, are distinguished both from atrophy and from cancer by special characters: from atrophy by the existence of vitiated secretion, proving the affection of the constitution, and by the presence in the affected bone of special morbid elements; although the latter difference can hardly be appreciated during life, except in those rare instances where the bones are swollen. From cancer they are distinguished by the strict limitation of the morbid product to the affected bones, and by the different progress of the constitutional affection; since the patient, if he dies of the disease at all, dies of the exhaustion produced by vitiated secretion, or from the effects of mechanical interference with the viscera; not, as in extensive formation of cancer, from perverted nutrition, still less from transference of disease to remote organs.

Our knowledge of the true pathology of this complaint is as yet quite deficient, and so it follows that no means of treating it are known. The patient's strength must be supported, and he must be guarded from all exertions and shocks. If bedridden, his position must be accommodated to the shape of his limbs, so as to correct, if possible, the existing deformity by gradual traction, and to prevent any greater distortion. The fractures which occur in these cases are sometimes excessively numerous. Dr. Ormerod's patient had "at one and the same time no fewer than seven fractures of different bones." Yet in this case the fractures used to unite with the same readiness as they do in rickety bones.

Many of the cases are hardly subjects for treatment, since the disease in the bones and the distortion of the limbs has advanced to an unmanageable extent before the patient is seen; and it would be scarcely desirable, even if it were possible, to protract the course of a painless but inevitable decay.

Cancer in bone. All forms of malignant disease are met with in the bones, but the encephaloid, or medullary, is by far the most common.* Osteoid cancer is almost confined to the bones as a primary disease, although a very few cases are on record in which it has been found in the soft parts, without any known cancerous affection of the bones.† Cancer in bone may be either a primary disease, or secondary on cancer in some other, and usually a remote, organ. As the general considerations applicable to malignant disease have been described in the essay on CANCER, it will only be necessary here to dwell on the peculiarities which are found in cancer when developed in the bones, with reference to its seat, manner of growth, and external appearances, and to endeavour to deduce the necessary inferences as to diagnosis and treatment.

With respect to its seat, no bone is exempt from the invasion of the disease, but some bones are far more liable than others; the long bones of the lower extremity taking the lead, and the femur being of all others most commonly attacked. Out of forty cases of primary cancer, twelve occurred in the femur, eight in the bones of the leg, five in the skull, three in the pelvis, and three in the spine. The others were single cases seattered about the various regions of the body. The neighbourhood of the knee-joint is a very favourite seat of cancer; so that a soft tumour springing from the lower end of the femur or the head of the tibia is always viewed with much anxiety. Out of the above-mentioned twenty cases of cancer of the long bones of the lower limb, eleven are noted to have grown near the knee-joint.

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* In the notes of fifty cases of malignant disease of the bones, which I happen to have by me, thirty-five are classed as encephaloid, four as osteoid, four as scirrhus, three as epithelial, one as areolar or colloid, one as melanosis of the periosteum, and the other two were tumours of doubtful nature and anomalous structure, but probably malignant. These notes, however, which are composed partly of extracts from books, partly of cases noted on account of interesting features, contain too large a per-centage of rare forms of disease. This is evident in the number of cases of osteoid cancer.

† See Paget, *Surg. Path.* vol. ii. p. 496.

The common kind of cancer in bone presents itself in three principal forms, viz. periosteal, interstitial, and infiltrated. The last is by far the least common. When carried to its extreme degree, the whole bone is softened by the distension of its cells with the material of soft cancer, leading to partial or complete absorption of the cancelli, and general disintegration of the bone. In this condition it forms one of the affections of bone which are included under the name "mollities ossium," under which head it has been referred to above. The periosteal form of cancer appears to be the more common in the long bones, while the interstitial is certainly the one more usually met with in the flat bones, such as the skull and pelvis, and in the joint-ends. The interstitial form is found in the shape of nodules of various, but usually small, size, scattered about the cancellous tissue. They are whitish in colour when small and recently deposited, and generally give out a creamy juice under pressure, exhibiting the various cell-forms usually met with in the juice of malignant tumours. In the harder kind of these nodules, following scirrhous cancer in the breast (and to which the designation "scirrhus of the bones," used by some writers, applies, while others call them "hard encephaloid"), I have sometimes been unable to recognise any cancer-juice, or any cell-structures characteristic of cancer.* This interstitial deposit of cancer is productive of constant and wearing pain in the part, very frequently followed, in a long bone, by fracture on some slight injury or even muscular exertion. After some time, during which, if fracture has taken place, it may have consolidated, a tumour makes its appearance. The disease, having overcome the resistance of the periosteum, now grows rapidly. On dissection, a large mass of soft cancer is found, in which the periosteal envelope of the tumour may or may not be recognisable, and which springs from the bone by a narrower base, while it generally extends further in the cancellous tissue, or to a still greater extent in the medullary canal. In rarer cases, several separate nodules are found scattered about the cancellous tissue. The bone in the neighbourhood of the cancerous deposit is often thickened,† sometimes to an extent that can be appreciated by external examination.

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* This was so in a case reported in *Path. Soc. Trans.* vol. xi. p. 220.

† Paget, *Surg. Path.* vol. ii. p. 302; *Path. Soc. Trans.* vol. x. p. 249.

The accidental peculiarities of shape and arrangement in the various specimens of interstitial deposit of cancer have given rise to different terms, which having now lost some of their significance, ought to be, and have very generally been, allowed to become obsolete. Thus, when such a deposit in the articular end of a bone grows into a number of cancelli in different directions, the whole of the head of the bone becomes enlarged, forming a sort of multilocular cyst, the spaces of which are filled with the tumour, and the surrounding part of the bone a good deal consolidated. Such a swelling has been called the *malignant exostosis.* In other cases the soft tumour expands the outer layer of the bone uniformly, without producing fracture, and thus a swelling is formed, the wall of which crackles under the finger. This was called a *spina ventosa.*

In the periosteal form, the tumour makes its appearance sooner and grows more rapidly than in the interstitial. The subjacent bone is generally quite unaffected, and a section of the disease shows a ring of healthy bone surrounded by a radiating mass of malignant substance. The periosteum appears in some cases to have degenerated and become converted into the structure of the tumour; in others, it may be traced over the tumour, which then seems to grow between the bone and periosteum.* In this form of the disease there is a strong tendency to ossification, so that, after maceration, a large quantity of irregular bony deposit is left on the surface of the bone, forming very often a coral-like mass, with some approach to a spiral arrangement of its laminæ. These specimens were often described by the older writers as periosteal exostoses, their true nature being overlooked in consequence of the bone not having been examined till after maceration.

Cancer in bones is sometimes said to be a less rapidly fatal disease than in the soft parts, and perhaps if we compare it (as would seem most correct) with the average duration of *soft* cancer in the soft parts, this may be so; but the difference is not very marked. In twenty-eight of the cases contained in my notes the disease was followed till the patient's death from its commencement, with such approach to accuracy as is possible in these circumstances. In twelve of them death took place in less than a year (in five in less than half a year) after the first symptoms were noticed by the patient, and ten of the others died within the second year. In two only of the remaining cases was the disease protracted much beyond the usual period of duration of cancer, but neither were cases of encephaloid cancer: one, a case of colloid, might possibly be erroneously classed among malignant diseases. The true encephaloid cancer, then, in the bones, as in other parts, is more rapidly fatal than scirrhus, although its progress in the bone may be somewhat less rapid than elsewhere. But besides the encephaloid, all other forms may in exceptional cases be met with. Some pathologists, indeed, deny the existence of scirrhus in the bones, preferring to call the small hard nodules found in the spine, skull, and long bones, secondarily after scirrhus of the breast, and more rarely after scirrhus of other parts, as "hard encephaloid." The difference in nomenclature is a matter of no importance. Hard cancer, indeed, when deposited in the bones, cannot of course draw to itself the neighbouring parts and thus reduce the volume of the organ in which it is placed, so that it is destitute of that puckering so characteristic of scirrhus of the breast. But in other respects it seems identical. The small irregular lump, creaking under the knife, emitting a very scanty juice, and presenting under the microscope, besides a good deal of common fibrous tissue, only small nuclear bodies, and those perhaps in no very large proportion, bears a sufficiently close resemblance to scirrhus in other parts to deserve the same name, more especially when only another product of the selfsame disease. Epithelial cancer attacks bones usually in the course of a cancerous ulceration of the soft parts which cover them, but scattered instances of its occurrence as a primary disease are on record. Thus in the *Patholog. Soc. Transactions*, ix. 358, will be found a description of this disease in the base of the skull. It presented the appearance of a mass of fibroid tissue, the meshes of which were filled with a yellow opaque and thick material, which could be squeezed out in the form of commedones, and consisted of a mass of epithelial scales. But these cases are of too rare occurrence to have much of practical importance; nor in the few scattered cases of colloid disease affecting bones with which I am acquainted, is there any thing to throw light on the controversy as to the malignant or non-malignant nature of that affection. Melanosis affects bones very rarely, and probably is always a secondary formation.* The osteoid cancer has been sufficiently described elsewhere in this work (vol. i. p. 533).

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* *Path. Soc. Trans.* vol. i. p. 320.

In the *diagnosis* of cancer of the bones two difficulties present themselves,—*first*, to distinguish between a soft tumour and an abscess or other inflammatory affection; and *second*, to distinguish between a malignant and an innocent tumour.

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* A few preparations may be found in our museums; *e.g.* St. George's Hospital museum, ser. ii. 234.

The diagnosis between a tumour and an abscess is sometimes very difficult. The question occurs only, as far as I have seen, in the neighbourhood of a joint; where also the question sometimes is, whether the swelling is not due to thickening of the synovial membrane. Generally speaking, however, the soft tumour is limited to one portion of the circumference of the bone, while disease of the synovial membrane would involve the whole circumference, although not necessarily equally prominent over the whole. Further, the chronic thickening of the synovial membrane will have been preceded by a long course of symptoms of disease in the joint, and these symptoms will probably have been more acute at some previous time; while the tumour will have commenced much more recently, at first without any symptoms, and the symptoms will have been more marked as the tumour got larger. Limited abscesses, also, in the thickness of the swelling, are common in the chronic synovial disease, while abscess is a rare complication in the course of a tumour, and then forms external to it and singly. The following instance of the occurrence of abscess around a rapidly growing tumour will illustrate the difficulty of the diagnosis in such a case. A young woman was recently admitted into St. George's Hospital, complaining of pain near the ankle; no diseased appearance then existed. Soon, however, a soft swelling made its appearance, fluctuation was detected, and an incision behind the internal malleolus gave exit to pus mixed with blood, and exposed a cavity which appeared to be that of an ordinary abscess. After a few days arterial hæmorrhage came on, and soon became uncontrollable. Pulsation also became evident in the swelling. The incision was extended, and several pieces of soft, breaking-down tissue escaped; the finger passed into a mass of fungous matter springing from the os calcis. After amputation the disease was seen to be a soft tumour, about the size of a walnut, connected by a broad base to the calcaneum, and surrounding the posterior tibial vessels. The artery showed a small perforation. It is seldom, however, that such difficulty is experienced as in this case in forming the diagnosis; and if from the ambiguity of the symptoms, and the thickness or tension of the soft parts over the swelling, doubt is felt as to the presence of a soft solid or a collection of fluid, the introduction of a grooved needle will in most cases decide the question. Usually the lobulated surface of the tumour, and the healthy and uninflamed state of its coverings, suffice to distinguish it from an abscess.

The diagnosis between malignant and innocent tumours is often very difficult, and sometimes impossible. It is of most importance, and unfortunately is also of most difficulty, in those which grow around the lower end of the femur. Malignant and myeloid tumours here often bear the strongest resemblance to each other, so that the diagnosis in an early stage of the cancerous affection can be only conjectural. By a reference to the essay on TUMOURS (vol. i. p. 492) the reader will see that the points to which the Surgeon is to direct his chief attention are the length of time during which the tumour has existed without constitutional or glandular affection, the bulk to which it has attained, and the extent of its attachment to the bone, since myeloid disease is an affection of the cancellous ends, while encephaloid often surrounds the shaft to a considerable extent, forming a long oval tumour, like a great ferule. But it must be allowed that the diagnosis between these forms of disease can hardly be expected to be accurate, inasmuch as there is strong reason for believing that myeloid tumours are occasionally malignant. There are other tumours also which could hardly be distinguished from cancer until a long progress had proved their innocence. Such are the fibro-cystic, to be afterwards mentioned, and such may also be the case sometimes with enchondroma, and with the diffused osseous tumour. It is only, however, in the very early period of osteoid cancer that its malignancy is not a prominent feature. It grows rapidly, extends far along the bone, and soon affects both the constitutional powers and the absorbent system.*

In general, malignant tumours of bone may be known by their large size and rapid growth, their soft consistence, the unequal density of different parts, the large veins which ramify over them, the extent of their attachment to the bone, the frequent presence of large sanguineous cysts, the amount of pain by which their growth is attended and often preceded, and the rapid destruction of bone which they occasion. To these local symptoms the general symptoms of the constitutional affection may be superadded.

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* Two cases of osteoid cancer of the femur have been in the surgical wards of St. George's Hospital within the last few years. In one, although the affection was not of long standing (less than a year, I believe), the inguinal glands presented the characteristic bony hardness. In the other, the tumour, which was mixed with encephaloid, was growing rapidly, and contained a large cyst, the tension of which occasioned much pain, relieved by drawing off the fluid. Amputation at the hip was successfully performed by Mr. Tatum; but the disease recurred in the lungs, and proved fatal in about half a year.

The treatment of cancer in all parts of the body resolves itself into the question of leaving it alone, or eradicating it. The only method of extirpating malignant disease of any bone which is at all satisfactory is by excising the tumour along with the whole thickness, at any rate, of the part of bone from which it springs. To remove the tumour from the surface of a bone, in the uncertainty which must always exist whether cancer has not also affected the interior, would be highly imprudent. Nor is this sufficient; for if the disease can be clearly made out to be cancerous, the whole limb, including the entire bone which is the seat of the disease, ought to be amputated. When the tumour is situated in the leg, this is a matter requiring comparatively little deliberation; the choice only lies between amputation of the leg and of the thigh, and the difference between one stump and another is of slight moment, compared to the risk of a return of malignant disease. But if the tumour affect, as it so commonly does, the lower end of the femur, the question becomes a grave one; since amputation at the hip-joint must be performed if the disease is clearly diagnosed as being cancerous. No other general rules can be laid down. If there is a reasonable doubt whether the tumour be soft cancer or myeloid, or whether it be hard cancer or diffused bony tumour, undoubtedly the wisest course is to give the patient the benefit of that doubt, and to remove the limb at the lowest level at which the incisions can be carried clear of the tumour. Even if the disease should prove to be cancer, possibly the recurring disease may be in the cicatrix, and amputation of the stump at the hip-joint may prolong life. But so many cases are on record in which what has been supposed to be malignant disease in this part (and which in all the cases was most likely myeloid) has been completely arrested by amputation of the thigh, that it is only right to try the milder operation in cases not evidently cancerous.* In the fore-arm the character of the disease is usually better marked (as far as I have seen), or in dubious cases the alternative is not of much importance; nor in the humerus is the removal of the limb at the shoulder-joint by any means so formidable in comparison as in the lower limb. Hence in the upper limb the rule should be the reverse of that in the femur, viz. that in cases of doubt the entire limb ought to be removed.

What is the benefit of amputation in such cases as these? This is a question very difficult to determine, if the question be limited to the expectation of life. Scattered cases are met with here and there in which a disease apparently malignant has seemed to be checked after amputation; nay, where it has recurred after amputation, and then been checked by amputation higher up;* but these are rare exceptions. The disease may be expected to recur, and to prove fatal; and the operation must be defended rather on the grounds of humanity than of scientific indications, as affording relief from present suffering, and the chance of an interval of some months, perhaps even longer, of health, rather than as holding out much prospect of a radical cure of the complaint.

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* See Mr. Gray's paper in *Med.-Chir. Trans.* vol. xxxix. p. 121.

Pulsatile tumour. A remarkable feature in malignant tumours of bone is the occasional occurrence of pulsation in them. This pulsation can sometimes be with difficulty distinguished from that of ordinary or sacculated aneurism. The resemblance also which these malignant tumours of bone sometimes bear to the aneurisms by anastomosis is so strong that they have been described almost down to the present time as "aneurisms of bone,"† and have been believed to consist merely of a dilated vessel or vessels in the interior of an otherwise healthy bone. But it is now admitted that the great majority, at any rate, of these so-called "osteo-aneurisms" were really pulsatile malignant tumours, and that the existence of any disease in the cancellous tissue of bone analogous to aneurism by anastomosis, and therefore curable by local measures, is highly doubtful, if not absolutely disproved. The resemblance, however, is in the highest degree perplexing when the pulsatile tumour occupies a situation where aneurism by anastomosis is common, such as the scalp.

A woman applied at St. George's Hospital some years ago on account of a pulsating tumour on the vertex of the head. Mr. Prescott Hewett, under whose care she was placed, came to the conclusion that the disease was a malignant tumour of the skull, and dissuaded her from any operation. Being anxious, however, to have the tumour removed, she consulted another Surgeon, who gave it as his opinion that the tumour was an aneurism by anastomosis, and might be extirpated. Mr. Prescott Hewett accordingly sought the advice of his colleagues, and after a careful examination they confirmed him in his original opinion, that the tumour was malignant, and had perforated the cranium. He therefore declined to operate; and the woman was placed in another hospital, by the advice of the gentleman whom she had subsequently consulted, and who then attempted to excise the supposed vascular tumour. The original diagnosis, however, turned out to be correct, and it became necessary to give up the operation. Such cases as these show the difficulties which may be experienced in diagnosing the nature of such a tumour in the scalp; but it more frequently occurs that the pulsatile tumour of bone is situated on the course of some large artery,* and simulates an ordinary aneurism.

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* *Path. Soc. Trans.* vol. vi. p. 291.

† See especially a paper by Breschet, "*Observations et Réflexions sur des Tumeurs sanguines d'un caractère équivoque, qui paraissent être des anévrismes des artères des os.*"

The anatomy of these tumours is as follows: they spring from the cancellous interior of the bone, expanding and eroding its external shell, until they burst out, frequently on both sides of the bone at once, forming lobulated masses, which sometimes attain a large size. On section they are seen to be red, of a fleshy consistence, and containing large spaces or cells filled with blood, from the pulsation of which the tumour derives its movements, and which must therefore communicate freely with the main arteries around, though the exact nature of that communication has not yet been demonstrated. The pulsation appears to depend on the resistance of the periosteum, which is often thickened. Hence, when the periosteum is penetrated, the pulsation frequently disappears; as that of an aneurism will do when the sac has given way. The microscopical characters of soft cancer can be recognised in the structure forming the walls of the cells. Spicula of bone are often found mixed up with the malignant matter. The tumour frequently affects the large veins in the neighbourhood, projecting into them, or even blocking them up; and several such tumours may exist together, or malignant disease of the ordinary encephaloid variety may be found in some other organ of the body. (See the case quoted on p. 384.)

The diagnosis of a pulsatile malignant tumour of bone is very easy in some cases, almost impossible in others. It is easy when the tumour springs from a superficial bone, lies away from the course of any large artery, and has no bruit; and still more so when other malignant tumours or symptoms of malignant disease are present; but where its connexion with the bone is obscure by reason of the depth at which its base lies, when a large artery (which is generally the iliac or gluteal) lies near its situation, when its pulsation is accompanied by bruit,* when the tumour is solitary and the general health unaffected,—it becomes a matter of the utmost difficulty. Enough, however, has been said above on this subject (see p. 383).

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* Such tumours may, however, form in any bone with copious diploë. In the *Edinb. Med. and Surg. Journ.* Nov. 1860, p. 452, is an account of one which implicated the basilar process of the occipital bone and the first three cervical vertebræ.

In cases where other tumours exist, or where the symptoms of constitutional cancer are present, no doubt can be felt as to the inefficacy of local treatment; the disease declares its malignancy by the same signs as cancer in other parts of the body, and its prognosis and treatment must be the same. But are there any pulsatile tumours of bone of a different kind, in which the Surgeon can hold out a hope that the excision of the tumour, or its consolidation by chemical agents, or by ligature of the artery which leads to it, will offer a reasonable hope of cure; or must the patient be sentenced to the hard alternative of death or amputation? The belief that these tumours are ever local, and are curable by local measures, is one which seems to become less strong as more cases are seen and followed to their termination. Thus Cruveilhier, who some time ago shared the then prevalent opinion as to the local nature of the "erectile tumour of bone," expresses himself with much more reserve in his latest work,† regretting that all the cases he has himself seen have turned out to be encephaloid; and such seems also to be Rokitansky's opinion.‡ If we may judge from recorded cases, almost every one in which the history has been followed out has run the usual course of cancer, and the existence of what used to be described as the osteo-aneurism, *i. e.* an innocent pulsating tumour of bone, in which it would be right to attempt to coagulate the blood by injections, or to produce consolidation by ligature of the main artery of the limb, is quite problematical, although many such attempts have been made, and failed. Lallemand's case§ is, it is true, usually quoted as a success; but this conclusion is premature, since the history terminates a few weeks after the operation. In several other of the recorded cases, a temporary improvement has followed ligature of the main artery in consequence of the diminution thus occasioned in the bulk of the tumour. Lallemand's case shows really no more than this. In Dr. Nicol's case,* there was, in like manner, a temporary diminution of the bulk of the tumour; though, as the patient died of secondary hæmorrhage from the tied artery, an opportunity existed to prove by dissection that the disease was cancerous. A case of this kind is related by Dupuytren,† in which the disease, which was situated in the tibia, was believed to have been cured by ligature of the femoral artery. The tumour, however, seems never to have disappeared; and when the patient was again seen, seven years afterwards, it presented all the appearances of malignant disease.

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* Cruveilhier (*Anatomie Pathologique*, 1856, vol. ii. p. 901) relates a very interesting case in which an encephaloid pulsatile tumour, springing from the bones of the skull, presented so marked a thrill, and a sound so exactly resembling that of arterio-venous aneurism, that he was led into the belief that such was the nature of the tumour, until dissection revealed its true character.

† *Anatomie Pathologique*, 1856, vol. iii. p. 895.

‡ Op. cit. vol. iii. p. 183.

§ Prefixed to Breschet's paper above quoted.

If, however, the existence of pulsating tumours in the bones formed by mere enlargement of the vessels must be allowed to be doubtful, it seems that pulsation has been recognised in a myeloid tumour;‡ and, as these tumours are usually innocent, it would follow that the mere presence of pulsation in a soft tumour of bone is not to be considered as a decisive proof of its malignancy. If, however, we allow this exception to the rule that pulsating tumours of bone are malignant, we must still admit that there is no reliable account of any such tumour connected with the skull or pelvis (those favourite seats of the disease) which was otherwise than cancerous.

If such are our views with respect to the nature of the pulsatile tumour of bone, our opinions as to the proper course of treatment cannot be doubtful. To tie a large artery is so very grave a measure, that it can only be justified by the clear prospect of impending fatal hæmorrhage, or by the presence of an aneurismal tumour pressing upon important organs. In these pulsatile tumours, however, hæmorrhage is rare, and only occurs late in the disease; nor are important parts often pressed upon, except in the cranium. If it be said that the growth of the tumour will be checked by the ligature of its nutrient vessel, the answer is, that this is by no means borne out by experience, and that even if its growth were checked, the disease would not therefore be cured; while the doubtful good to be derived from a very uncertain diminution in the bulk of the tumour is as nothing when compared to the frightful risk of tying a large artery in a subject probably already debilitated by the cancerous cachexia. In many of the recorded cases, the ligature of the main artery appears so far to have affected the tumour as to have checked its pulsation. But the pulsation, though a formidable symptom, is not an essential, and may not even be a constant, part of the disease. Thus Professor Miller relates* a case of pulsatile malignant tumour in the ham, which was at first mistaken for aneurism. The pulsation disappeared spontaneously, but returned after an exploratory puncture made in the tumour. Afterwards the pulsation varied, disappearing occasionally, and then recurring.

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* *Edin. Med. and Surg. Journal*, vol. xlii. p. 19.

† *Leçons Orales*, Paris, 1839, vol. iii. p. 232.

‡ Gray on *Myeloid Tumours of Bone*, *Med.-Chir. Trans.* vol. xxxix. p. 138.

The purport, then, of all that has been noted as to the course and nature of this disease, and as to the effect of treatment, appears to justify the following conclusions: that in pulsatile tumours connected with the bones of the extremities, amputation should be recommended through or above the nearest joint, except in those connected with the lower end of the femur, where it may occasionally be advisable to amputate near the tumour; that the ligature of the main artery of the limb is unjustifiable, especially as all the benefit which could be derived from that operation might, in many cases, be equally well obtained by compression;† that in pulsatile tumours connected with the head, chest, or pelvis, no local measures ought to be employed, but the disease should be treated as one of cancer; and finally, that the prognosis may be rendered somewhat less grave by remembering that pulsation has been noted in a myeloid tumour.

Cancerous ulceration is usually preceded by a known and evident tumour, probably epithelial; but in some cases the malignant deposit may have been entirely interstitial, and in others the patient is not seen until extensive ulceration has destroyed any tumour that might have existed. Such cases occur most usually about the bones of the face; and I have seen death produced where the lower jaw was implicated in a case of this kind, by the extension of the ulceration into the lingual artery. During life some difficulty may be experienced in distinguishing this cancerous affection from the rodent or phagedænic ulceration, spoken of at p. 639; but it is a matter of little practical importance, since amputation or complete excision would be recommended in either case, if the patient's general condition admitted of it. The bones of the face are peculiarly liable to extensive destruction in cancroid ulceration and in lupus, but the chronic course of these affections sufficiently distinguishes them from cancer.

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* *Edin. Med. and Surg. Journal*, April 1860, p. 963.

† Compression in such cases should be *digital*, since it is important not to interfere, if it can be helped, with the venous circulation.

In the macerated bone, malignant ulceration produces extensive and irregular destruction both of the compact and cancellous tissue, without any trace of the periosteal and other inflammatory deposit that bounds the more healthy forms of ulceration.

NON-MALIGNANT TUMOURS.

Tumours of bone are like those of soft parts in all important respects. They are innocent or malignant; the former being, for the most part, composed of some of the same structures as form the bone itself, in a more or less perfect state of development (homologous tumours); while the malignant tumours are composed of other structures, to which the osseous tissue in a state of health presents no analogues (heterologous). The parts which compose a bone are fibrous membranes, cartilage, the proper osseous tissue or granular base, and blood-vessels; together with the spaces or cancelli filled with fat, which give the bone the requisite lightness. Now any of these elements over-developed or imperfectly imitated may give rise to a tumour. The overgrowth of the fibrous tissue gives rise to the true fibrous tumours; its imperfect imitation by morbid action produces the various forms of fibroid or fibro-plastic tumour; excessive or misplaced growth of cartilage results in enchondroma; of bone in exostosis. Whether the vessels of bone are ever simply over-developed, without any other morbid product, so as to form the "osteo-aneurism" spoken of by numerous surgical pathologists, is a question which has been discussed above. From the over-distension of the cellular spaces of bones, some of their cystic tumours probably arise; others are formed by a peculiar arrangement of the connective tissue in tumours belonging to different classes; and some of the growths, which are classified with cysts, are merely entozoa in the cancellous tissue. Lastly, analogous to the fat and medullary tissue which fills the cavities of the bones we have a class of tumours, the myeloid, which, since their first description by Mr. Paget, have not ceased to attract much attention, on account of the interesting surgical and pathological questions connected with them.

Enchondroma. Cartilaginous and bony tumours can hardly be treated of separately, for although the well-marked specimens of either class present little similarity at first sight, some of each are so intimately related, that the two could not without confusion be made the subjects of separate sections.

Cartilaginous tumours, or enchondromata, as they are called, have been already described in the essay on TUMOURS (vol. i. p. 486), so that it now only remains to speak of them as they affect the bones.

These formations may be divided, for surgical purposes, into two classes: viz. those which do, and those which do not, show a tendency to ossify. The latter usually grow as extensive infiltrations into the tissue of the bone and periosteum, and in the course of time spread slowly over the surface of the bone (retaining for the most part their covering of periosteum), and fill all the spaces or cavities in relation with the bone. It is difficult to determine their precise origin, and thus to make sure whether they are new formations, in a strict sense, or out-growths; but the former opinion seems more generally probable. I have, however, met with one of these tumours, in the phalanx of the finger of a child, where it seemed probable that the origin of the tumour was the epiphysal cartilage. These non-ossifying cartilaginous tumours, or pure enchondromata, are little amenable to surgical treatment, unless in a part favourable for amputation. They have been supposed to present some analogy to malignant diseases, to which, indeed, their extensive diffusion and steady irresistible progress do offer a resemblance. They differ, however, from the true cancers at any rate in one feature, which is quite characteristic, viz. that however extensive their diffusion, they affect the surrounding parts only by pressure or absorption, not by contamination. This is their most distinctive feature; but it is not so useful in diagnosis (since it is less easily appreciated during life) as their rate of growth, which is usually slow. To this rule there are, however, rather frequent exceptions, of which three remarkable instances are related by Mr. Paget,* in one of which the rapid growth of the tumour led to the erroneous diagnosis of malignancy, and so deprived the patient of the chance of recovery which amputation would have given him. Remembering these and similar cases, we must not be too confident in inferring malignancy in the case of a tumour of bone from the single fact of rapidity of growth, although that is, doubtless, a most suspicious and unfavourable symptom. In many cases, these large cartilaginous tumours remain stationary for a long period; and this should be taken into consideration when consulting on the propriety of amputation.

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* *Lectures on Surg. Path.* vol. ii. p. 181.

The structure of these tumours varies; usually they are quite solid; in other cases cysts, filled with fluid, are found in them. They sometimes consist exclusively of cartilage; but more commonly fibrous tissue is to be found, in sparing quantity, in some parts of them. The microscopical appearances will be found described in the essay above referred to (see vol. i. p. 489).

The circumscribed cartilaginous tumours are, however, much more frequently met with, and are, therefore, more important in practical Surgery. They spring almost exclusively from the long bones, the phalanges of the fingers and toes being their most frequent seat. In these situations they are often found in great numbers at the same time; and the appearance thus presented is very characteristic, and is not, as far as I know, imitated by tumours of any other kind. The fingers are studded over with bosses or knobs, looking something like the dry gnarled branches of an old tree.* This affection is seen generally about the age of puberty. It is, of course, quite incurable, except by amputation; but that measure should never be resorted to in any disease of the hand without evident necessity. In the foot less scruple need be entertained, since the foot, deprived of its anterior portion, is still a very useful member; and there would be no necessity, even in a very advanced case, for going further than Lisfranc's or Chopart's operation. I have never seen a case where any thing more was required than to remove one or two toes. In the hands, these multiple enchondromata, if left alone, grow generally very slowly, and sometimes not at all. Cases are, however, on record where they seem to have increased slowly during the whole period of life, and to have attained at length a truly extraordinary development. Of this the specimen figured by Müller† is an excellent instance; and a very similar case has been described and figured by the writer,‡ where, however, the cartilaginous structure was less distinct. Such tumours usually originate in the interior of a bone, expanding its walls into a thin bony cyst or shell, which is liable to give way at different parts, and firm pressure will then elicit a feeling of crepitation. These multiple enchondromata, like the diffused cartilaginous tumours just described, seem to show little tendency to ossify in the strict sense of the term; but they undergo, when very old, a process of calcareous degeneration, which, added to their general increase in size, produces ulceration of the skin over them; and so a condition is brought about not unlike that of a mass of enormous chalkstones exposed. More rarely the tumours spring from the surface of the bones.

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* There is a good model of this affection (a cast taken from life) in the museum of St. George's Hospital.

† *Ueber den feinern Bau und die Formen der krankhaften Geschwülste*, Berlin, 1838, tab. iv. fig. 1.

‡ *Path. Soc. Trans.* vol. ix. p. 382. The specimen is in the museum of St. George's Hospital.

Circumscribed and solitary enchondromata usually grow from the surface of a bone, and most of them show a strong tendency to ossify, the process commencing generally at the base. Hence the surgical considerations applicable to them are identical with those which apply to exostosis.

Diagnosis. The diagnosis of innocent tumours from each other is uncertain and obscure in all parts of the body, and perhaps more so when they are connected with the bones, on account of the generally deep position of the latter. If, however, a tumour presenting the general characters of innocency can be clearly made out to be springing from bone, the chances are very great in favour of its being an enchondroma or an exostosis. If very large, it can hardly be the latter without displaying characteristic hardness. Fibrous and fibroid tumours may be found of large size; still almost all large non-malignant tumours of bone are cartilaginous. Most, also, of the smaller tumours, which do not possess the hardness of exostosis, will be found to be cartilaginous. Such tumours usually possess a certain amount of resilience, and often appear obscurely movable on the bone. This sensation, however, is often deceptive, and due, apparently, to the motion of the soft parts upon the tumour; it has been noticed in tumours, the base of which has been found to be completely ossified, and a slight amount of apparent movement is therefore no conclusive reason for denying the connexion of a tumour with the bone. Another thing which ought to be taken into account in diagnosis is, that the cartilaginous, equally with the osseous, tumours may have a bursa over them. This will not often be an obstacle in the way of making out an exostosis, since the hardness of the latter is transmitted through the fluid, but may sometimes cause doubt about the nature of an enchondroma. The nodulated surface of enchondroma, though characteristic to a certain extent, is far from distinctive of the disease; the same property may belong to colloid disease, fibrous tumour, and other swellings; in fact, the only sensation which affords a reasonable ground for pronouncing a tumour cartilaginous is resilience combined with solidity, and this for deep-seated tumours is often deceptive, and in the many enchondromata enclosed in shells of bone is, of course, absent. On the whole, therefore, an enchondroma is best known by its being an innocent, and not osseous, tumour; elastic when firmly pressed, generally growing slowly, and not affecting the skin. When the phalanges are the seat of the disease, the diagnosis is much more nearly certain.

Exostosis. The transition from cartilaginous to bony tumours is a natural one, since so many of the former are merely the first stage of growth of the latter. The term "exostosis" is not a very easy one to define. It ought to be used only to signify an innocent tumour, or limited out-growth, formed exclusively of bone, and not the result of inflammatory action; but, on the one hand, the products of inflammation secreted by the periosteum often assume the form of a limited out-growth or tumour; while, on the other, many complex malignant tumours possess a bony framework, and, after maceration, bear a great resemblance to exostosis. In the latter case the distinction, though occasionally difficult after the bone has been macerated, is easy during life; so that the mere fact that a malignant tumour possesses a more or less perfect bony framework is of little moment in a practical point of view. Most of the growths which fall under the category of "periosteal exostosis"* are extensive inflammatory deposits beneath the periosteum, which neither require nor admit of surgical treatment. Whether limited, pedunculated, and therefore removable, tumours ever occur as a consequence of inflammation is as yet doubtful; but it is highly probable that they do, both from the analogy of the elongated processes sometimes found projecting from the bone in the neighbourhood of fractures which have been consolidated with more than the usual amount of inflammation,† and also from the following considerations. Exostoses are occasionally found attached to the bone only by a neck composed of fibrous tissue. The occurrence of masses of new bone around the articular ends in the inflammatory disease known as "chronic rheumatic arthritis," and the probability that such masses become subsequently blended with the original bone, is now a familiar fact in pathology.* Specimens have been exhibited in which it seemed that inflammatory appearances could be traced around some of the loose exostoses previously referred to;† so that it is possible that some exostoses may be developed, as the masses of bone are which form so striking a feature of chronic rheumatic arthritis, in the soft structures near the bone, as a result of inflammation, and may afterwards coalesce with the original bone. The great majority, however, of those bony tumours which are called, in surgical language, exostoses, originate by an out-growth or limited hypertrophy of analogous parts, just as fatty, fibrous, and other innocent tumours do, quite independent of any inflammatory symptoms. Many authors, especially the French Surgeons, speak of "bullous exostoses," meaning apparently by this term those shells of bone which sometimes are formed by the development of a tumour (generally cartilaginous) in the centre of the shaft. The diagnosis and treatment of such cases will be found described elsewhere. Another kind of exostosis is that which proceeds from the ossification of tendons, or from the occurrence in man of processes of bone natural to the lower animals. Both of these belong rather to the class of museum curiosities than of subjects of practical interest. Still, if they became objects of treatment, they would probably be indistinguishable from exostoses, and would require the same operation. Few museums are without a specimen of ossification of tendons and other fibrous tissues. Some cases of this kind will be found referred to on p. 535, where also the treatment of persons presenting this tendency is discussed. Such cases as those in which a process projects from the humerus around the brachial artery, when that vessel follows the course usual in the large feline animals, in which it is surrounded by a ring of bone, only need to be known in order to avoid operative interference; and in any operations on bony tumours in regions where such anomalies are known to exist, the nature and history of the case ought to be first carefully investigated.

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* See Gerdy, *Maladies des Organes du Mouvement*, p. 272; Fano's edition of Vidal de Cassis, *Pathologie Externe*, vol. ii. p. 261.

† See a preparation in St. George's Hospital Museum, series i. no. 166.

Excluding these rarer varieties, the cases of circumscribed exostosis which Surgeons have to treat are divided into two classes—the cancellous, and the ivory; the former being a reproduction of the tissue of the interior, as the latter is of the hard exterior of the bone. They will be found fully described in the essay on TUMOURS (vol. i. p. 493).

Treatment. The slow rate at which exostoses progress, and the ease with which the soft parts accommodate themselves to the gradual advance of the tumour, render it frequently unnecessary to meddle with them; and it is always right to defer the operation until it is clearly seen to be necessary; since there is always great risk in operating on any deep-seated tumour, and still greater in laying open the cancelli of bone, as must be done in dividing the neck of an exostosis. Diffuse suppuration in the intermuscular spaces, erysipelas, and pyæmia are very liable to follow such operations. When the exostosis is of the ivory variety, and situated on the cranium, the operation is much more dangerous. Here, indeed, it not unfrequently happens that the tumour is so hard as to resist all the tools which can be brought to bear upon it, so that it is physically impossible to remove it. A striking example of this occurred in a case which has furnished a preparation to the museum of St. George's Hospital.* A man, suffering from a small ivory exostosis in the frontal region, fell under the care of the late Mr. Keate, one of the boldest and most skilful operators of his day, who perseveringly, but vainly, endeavoured, by the use of trephine, saw, chisel, and mallet, during the space of nearly two hours, to cut off the little lump of hard bone. The patient was fortunate enough to recover from this proceeding; and Mr. Keate, convinced of the uselessness of further operation, determined to attempt the extirpation of the tumour by the free application of potassa fusa and nitric acid to its exposed base. This was successful. The caustics, in the course of years, eat their way through the base of the tumour, which dropped off. The tumour still shows the deep groove worked into it by the trephine at the time of the operation.

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* On this head I would especially refer to a paper by Mr. W. Adams, in *Path. Soc. Trans.* vol. iii. p. 156.

† Gay, in *Path. Soc. Trans.* iv. 244.

It would be rash to say that such operations are unjustifiable, since exostosis in the neighbourhood of the orbit may grow into that cavity, or into the cranium, and cause death, or some horrible deformity almost worse than death, by displacement of the eyes, or bones of the face;† but the risks of operating on these small exostoses about the cranium should be maturely weighed. Some tumours, however, which present on the surface the character of the true ivory exostosis, may turn out on section to be hard only on the exterior, and to consist of a soft diploic tissue internally. This is the case usually, if not solely, when the bone from which the tumour springs resembles the composition of the vault of the skull, that is to say, consists of diploë covered by a thin table of compact tissue. In bones of which the shell is more dense, such as the lower jaw, it is much more probable that the whole thickness of the tumour will be of compact structure. The exostoses which consist of diploë internally, covered by a thin shell of hard substance (and which I venture to think more common than they are usually said to be), are, of course, much more easily removed than the true ivory exostoses which they simulate; and another circumstance which renders the prospect of operations on large exostoses, whether on the skull or other parts, rather more promising than would appear at first sight, is that the tumour when exposed is sometimes found to be connected to the surface of the bone by a very narrow neck, from which it can be easily broken or cut off.* It is, however, only rarely that either the Surgeon, or the patient, will make up his mind to the dangerous and doubtful experiment of an operation on an ivory exostosis, especially of the cranium; whereas operations on the more common forms of exostoses which spring from the shafts of the long bones, and present the cancellous, or mixed cartilaginous structure, are of daily occurrence. Their most common situation, after the phalanges, is near the knee, springing from the inner surface of the femur, a little above the condyle. Another very common situation is beneath the deltoid muscle.

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* Series ii. no. 189.

† Some remarkable specimens are in the Museums of St. Bartholomew's Hospital, and of the College of Surgeons. Exostoses of the orbit are not always of this dense quality. See a case in *Path. Soc. Trans.* vol. xi. p. 264, where the tumour was soft, and easily removed.

The removal of such an exostosis is, in most cases, easy, since the base is not generally very broad, nor the ossification very compact. Some are even so soft as to be divisible with a strong scalpel. A few again are not united to the shaft by bony matter, but by ligamentous union.† This condition is highly favourable for operation, not merely because the tumour can be more easily excised, but also because the vascular spaces of the bone will not be laid open in the operation.

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* A most interesting case of a tumour of this kind, growing from the cranium, is reported in the *Path. Soc. Trans.* for 1850, p. 149, with a drawing, and has been commented on by Mr. Prescott Hewett in his Lectures on Diseases of the Head.

† The observations made on p. 689, and the case of Mr. Gay's patient there referred to, will render it probable that exostoses are sometimes formed in the soft parts around the bone. These, of course, are connected to the bone, at least originally, by ligamentous tissue. Again, ossification of an enchondroma may proceed from without inwards, instead of its more usual course from within outwards. In a third class of cases, exostoses may be movable on the bone as the result of fracture. See a preparation in the Museum of St. Bartholomew's Hospital, series A, no. 183.

In other cases the tumour is broader, and more firmly ossified, at its base than in any other part; and these are the least favourable cases for operation, since the division of so large a mass of bone requires great and prolonged violence, peculiarly likely to be followed by the complications above enumerated. But the operation is necessary when the tumour is growing, and is threatening the functions of important parts; and in such cases the operator must be prepared for the difficulties which he may have to encounter, and should have a sufficient supply of instruments of adequate strength at hand, such as stout bone-nippers, saws of various shapes, chisels, and mallet. In all cases the base of the tumour should be clearly exposed, and separated with care from the parts around, which may require to be held back with retractors. The separation should be commenced from the side where any danger is to be apprehended (*e.g.* in consequence of the proximity of a vessel or joint), in order to avoid implicating any important part; and then any amount of force necessary must be carefully but firmly applied, the bone being steadied by assistants.*

The "bullous exostosis," or central enchondroma contained in a bony cyst, usually requires amputation of the phalanx upon which it is seated.† It may, indeed, be sometimes possible to enucleate the growth, and I have seen this done with success; but as a general rule it is hardly worth while to attempt it; since, if the disease be seated in the hand, the necessary disturbance of the tendons would probably render the finger useless; and if in the foot, the certainty of a speedy and complete recovery would outweigh the advantage of preserving a portion of one of the toes.

Diffused bony, or innocent osteoid, tumour. Besides these forms of limited exostoses, a diffused bony tumour is occasionally met with, in which the whole thickness of the bone for some distance is converted into a lobulated mass of spongy bone, which, in a section of such a tumour that I had the opportunity of examining microscopically, presented the usual structure of bone, but with smaller cavities, and an increased deposit of the granular base. The specimen (in the Museum of St. George's Hospital, series ii. no. 185) is larger than a man's fist, and involves one side of the lower jaw, from the condyle to near the symphysis. Its innocent nature is clearly proved by the fact that it had been growing for five years without any detriment to the general health, and had been partially removed on a previous occasion without any ill consequences from cutting into the interior of the tumour. On the patient coming under the care of Mr. Tatum, the tumour was completely excised, and with success, as the man was seen in perfect health several years afterwards.*

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* It may not, perhaps, be out of place to remark, that in case of an exostosis situated near the knee-joint, there is the more danger of opening the joint, since the presence of the tumour has probably caused numerous attacks of synovitis, which have left the pouch of synovial membrane extending up the thigh permanently enlarged.

† I have never seen a tumour of this sort connected with the larger bones; but the statement in the text would apply still more forcibly to such a tumour.

Another still more remarkable case is illustrated by a series of three preparations in the Museum of the College of Surgeons. The history is so interesting that a condensed report of it must be introduced. The thigh was originally amputated on account of a hard and heavy dry osseous substance, surrounding the ends of the femur and tibia, projecting into the knee-joint, extending far up the thigh, and implicating the popliteal artery, vein, and nerve, so as to cause œdema and severe pain (Prep. no. 3244). The patient remained well for five years; then another osteoid tumour formed on the stump of the femur, accompanied with severe pain. Amputation was performed higher up. The tumour appeared to grow, not from the bone itself so much as from the periosteum, and enclosed the femoral artery (Prep. no. 3245). There was again an interval of health for two years; then a fresh tumour formed about the stump, continued to increase upwards, out of reach of operation, and finally killed him, from inflammation and sloughing of its soft coverings, *twenty-five years* after the first appearance of the disease. He had been in good general health during the whole time (Prep. no. 3245, A).†

This history presents a remarkable analogy to that of the recurrent fibroid, or fibro-plastic, tumours of soft parts. There are the same leading features, viz. the local malignity of the disease combined with innocence constitutionally, its imperfect imitation of the tissues in which it grows, its constant recurrence near the site of an operation, and, finally, the mode of death—from exhaustion and sloughing after repeated operations, not from infection of the system.

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* *Path. Soc. Trans.* 1848-9, p. 95.

† Another, and very similar, case may be found in Mr. Paget's *Lectures on Surgical Pathology*, vol. ii. p. 506.

Cysts in bone are of two kinds; viz. serous and sanguineous. The serous, or mucous, cysts which occur in the jaws as a consequence of irregularity of the growth, or position, of the teeth will be found treated of in a subsequent essay. In such cases the formation of a cyst containing clear fluid is susceptible of an intelligible explanation; but it is difficult to see how simple serous cysts can be developed in other bones, and probably the few cases which are to be found in books rest upon erroneous diagnosis.* But cavities containing clear fluid are formed in bones by the growth of hydatids in their interior; and if simple cysts do occur, they would be indistinguishable from hydatid cysts before operation, and would require the same treatment.

Blood-cysts are not of common occurrence, nor is it usually easy to determine their pathological nature. Many of the cases reported under this title appear to have been examples of malignant tumour, in which a cyst has been developed, much exceeding in relative size the solid portion of the growth.† The most distinct description of a blood-cyst in bone to which I can refer is by Travers, in the *Med.-Chir. Trans.* vol. xxi. He excised the greater part of the clavicle, on account of a large cystic tumour of about a year's growth, which was very clearly connected with a history of injury. The tumour consisted of an arrangement of cells or chambers, of pretty equal dimensions, filled with dark solid coagula of blood, with spicula of bone in their walls, and invested by a very stout fibrous membrane. "The investing membrane was evidently the condensed periosteum, the cells were the irregularly-expanded cancelli, and the calcareous particles were the débris of the bony plates and walls." Travers is inclined to attribute the disease to expansion of the bony cancelli from blood effused into them as the result of violence. If this explanation be accepted, the affection would be identical with the blood-tumour, or hæmatoma, which is occasionally found in the soft parts as the result of contusion (see vol. i. p. 574). Mr. Stanley also relates a case‡ in which he amputated the thigh successfully on account of a blood-cyst originating in the condyles of the femur, and where both the femur and the tibia presented "an ecchymosed condition from minute effusions of blood through their compact tissue." This condition existed in the femur up to, if not above, the level of the amputation; yet the disease had not recurred six years afterwards. Mr. Stanley, however, in his description of this tumour, is careful to mention the fact that there were distinct portions of solid matter attached to the inside of the cyst, and would evidently, but for the progress of the case, have been inclined to refer it to the incipient stage of cancer.*

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* Mr. Stanley (op. cit. p. 194) denies the formation of simple cysts in any other bones than those of the jaw.

† See a case reported by Mr. Liston, under the name of "ossified aneurism of the subscapular artery," *Ed. Med. and Surg. Journ.* vol. xvi. pp. 66, 215.

‡ Op. cit. p. 187.

Blood-cysts could only be distinguished from serous or hydatid cysts by puncture. In the great majority of cases they would require complete removal, by amputation if necessary. If the Surgeon can satisfy himself of the absence of all soft solid matter around the cyst, he may in rare cases be justified in endeavouring to procure its obliteration by laying it open and stuffing it with lint; but it must be borne in mind that such measures can only do harm if there be any thing of a malignant taint about the disease.†

Fibrous and fibro-cystic tumour. The great majority of the innocent tumours of bone which are not osseous will be found to be cartilaginous or myeloid; but a smaller number present the fibrous character more or less perfect. Perfect fibrous tumours appear as out-growths from the periosteum; and the most familiar examples of them are the fibrous polypus of the nose, of which mention has been made in the essay on DISEASES OF THE NOSE, and epulis, which will be found treated of among the DISEASES CONNECTED WITH THE TEETH. As in other situations, fibrous tumour could hardly be distinguished from enchondroma before removal, and the diagnosis, even if it could be made, would be quite unimportant. We need not, therefore, give examples of the disease occurring in other parts of the body. Scattered specimens will be found in most of our large museums, and in many of them ossification will be found to have made some progress. In some of these cases the innocent nature of the disease is proved by the history, in others it is an inference from the structure of the tumour. Calcification occurs in these as in other fibrous tumours (St. George's Hospital Museum, ser. ii. no. 152).

Fibro-cystic tumour of bone is a disease which is little known, and may therefore possibly be of very rare occurrence. It is, however, also possible that this apparent rarity may be due to the fact that most of the examples of this disease have been confounded with malignant tumours. A very interesting account of a growth of this sort connected with the femur, in which the limb was removed at the hip-joint by Mr. J. Adams, will be found in *Path. Soc. Trans.* vol. v. p. 254, and, appended to the account of this case, a report by Mr. Prescott Hewett on three similar cases, in all of which the femur was the seat of the disease, and in all of which the patient recovered after amputation, and remained well for many years afterwards. There is therefore the strongest reason to believe that the disease was not cancerous. It commenced, in each of the four instances alluded to, in the cancellous tissue of the bone, making its way outwards, infiltrating the shaft, and causing spontaneous fracture; so far, therefore, exactly resembling cancer. It gave the sensation of an elastic substance, with fluid here and there in cavities. There seems to have been no diagnostic mark between it and cancer during life, except the negative indications to be derived from the absence of glandular or constitutional contamination during a somewhat long disease, the duration of the affection being, in the two cases in which that point was noted, three and four years respectively. On examination after removal, the innocent nature of the disease was inferred from the large quantity of firm glistening fibrous tissue of which nearly the whole solid portion of the tumour was formed, the presence only of such cellular elements as are found in growing fibrous structures, and the absence of cancer-juice, or any other indication of a tendency to disintegration in the tumour, or infiltration of neighbouring tissues.

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* It is possible that this affection may have been, as Mr. Paget hints, a myeloid tumour, in which the cysts, which are so common in that disease, were developed out of proportion to the solid part (see vol. i. p. 491).

† In Nélaton's *Path. Chir.* vol. ii. p. 48, will be found a striking representation of a large multilocular cystic tumour developed in the femur, and containing bloody fluid. Unfortunately there is no history of this case.

Myeloid tumours, the only other form of innocent tumour which it is necessary to particularise, will be found sufficiently described in vol. i. p. 490.

Entozoa in bone. A very few words must suffice for the description of the cases of entozoa in the interior of bone. The entozoon appears to have been the ordinary echinococcus in all cases except one quoted by Mr. Stanley, in which the cysticercus telæ cellulosæ is said to have been found in the interior of one of the phalanges. The subject is of no very great practical importance, since it is seldom possible to diagnose the nature of the affection previous to operation. The cases are so rare, that in the great work of Rokitansky* only eight are referred to, as the total number which he supposes to have been then observed. A search, however, through the various pathological collections would probably discover many more than these.[*] It is noticed by Rokitansky,[†] that the disease appears often to be directly induced by some injury; but it is difficult to believe that this can be otherwise than accidental. The disease runs a protracted course, and if the shaft of a long bone be the part affected, fracture, spontaneous or accidental, is very probably the first thing noticed. The fracture, in all probability, does not unite; and it has sometimes happened that in an operation, undertaken for the purpose of resecting the ends of the fracture, the hydatid cavity has been exposed and the globular acephalocysts discharged.[‡] Amputation is then indicated in ordinary cases; but one is on record, in which the hydatids were scooped out of the cavity of the cyst, which then filled up, and a complete cure was obtained.[§] In other cases, the seat of the disease is in a flat bone, as the skull,[||] or ilium,[¶] or in the expanded head of one or more of the long bones.[**] These cases are quite within the reach of cure when their nature is discovered; and in some rare instances, as in Mr. Coulson's and Mr. Stanley's cases, the discharge of hydatids through a spontaneous opening or a puncture, enables the Surgeon to determine the nature of the disease beforehand. Failing this, the symptoms are precisely those of any other cystic tumour of the bone.

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* *Syd. Soc. Trans.* vol. iii. p. 184.

The treatment appears to be usually successful. The cyst is to be freely laid open, with the trephine or bone-nippers if necessary; all the hydatids removed, and some caustic[††] applied to the whole interior of the cyst. In most of the recorded cases this has been sufficient; but in Mr. Coulson's case the cure was not completed until after the separation of a small piece of bone from the floor of the cavity, which on examination was found thickly studded on both its surfaces with a great number of minute hydatids

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[*] The contiguous Museums of Guy's and St. Thomas's Hospitals contain five specimens.

[†] Loc. cit. See also the histories of the cases which have furnished the specimens to St. Thomas's Hospital Museum, marked ser. c, nos. 230, 253.

[‡] Dupuytren, *Leç. Orales*, Par. 1839, vol. i. p. 52; St. Thomas's Hospital Museum, ser. c, no. 230.

[§] Mr. Wickham's case, *London Medical and Physical Journal*, vol. lvii.

[||] Keate, in *Med.-Chir. Trans.* vol. x. St. Thomas's Hosp. Museum, c. 6^1.

[¶] Stanley, op. cit. p. 190.

[**] Coulson, in *Med.-Chir. Trans.* vol. xli. In the specimens in St. Thomas's Hospital Museum, c. 253-4, hydatids were found simultaneously in the lower end of the femur and contiguous head of the tibia. Other cases are noticed in the bodies of the vertebræ. Dupuytren, loc. cit. Guy's Hospital Museum, no. 1029^{30}.

[††] Nitrate of silver, lint impregnated with a saturated solution of sulphate of copper ("blue lint," as it is called at St. George's Hospital), caustic potash, and the actual cautery, have been used.

Hypertrophy and Atrophy of Bone.

The condition of bone usually known by the name of hypertrophy is very generally the consequence of chronic ostitis, and would perhaps be more conveniently designated by some name expressive of its inflammatory origin. Thus, most of the specimens of "hypertrophied cranium" seen in our museums will be found, if the history be known, to be taken from cases of injury, or to be connected with syphilis or scrofula. The cases also of elongation and thickening of the bones of the leg, related by Mr. Stanley* under the head of "hypertrophy," appear all of them to fall more naturally under consideration with the sequelæ of inflammation, which have been described above. It appears that this thickening may go on for an indefinite period after the cessation of any symptoms, and that the enlargement of bulk which follows from it is permanent. It is true that in many of the cases of thickening, whether of the skull or of the long bones, which are preserved in pathological collections, no history of injury or inflammatory affection has been obtained; but the exact resemblance of the specimens to those in which such a history does exist, leaves no doubt that most of them are specimens of chronic inflammation. Cases do, however, occur, though so rarely as to be rather matters of curiosity than practical interest, in which a bone (the skull, for the most part) has gone on increasing in size without any symptoms except those produced by its increase in bulk. Such was the well-known instance related by Mr. Prescott Hewett, in his lectures at the Royal College of Surgeons, in which a man's skull continued to increase in size from year to year, with no symptoms whatever, so that he was only aware of the fact from the increasing size of his hat. The disease, however, in this case was clearly traced to an injury. As no symptoms can be attached to such cases, no treatment is known to have any influence upon them. In the absence of any constitutional affection, the persevering use of counter-irritation, by iodine or blistering, would appear to hold out most hopes of checking the growth.

Atrophy of bone is a more frequent and a more important disease than the opposite condition of hypertrophy. Inflammation, fatty degeneration, disuse, and injury, are frequent causes of atrophy; and there is also a simple atrophy, in which the composition of the bone is unaltered, and in which no obvious cause is present (unless it may be the general failure of nutrition in advanced life), and where the amount of bony tissue becomes gradually less and less, until the bone is no longer strong enough to resist slight violence.* As a consequence of senile change, or fatty degeneration, atrophy is one of the most common causes of spontaneous fracture. It may also occur in any bone, to some extent, as a consequence of confinement during a lingering disease.† Brodie says,‡ "All bones in a state of inaction lose a great part of their phosphate of lime. After compound fracture, when the patient has been long confined, the bones in some instances become as soft as a scrofulous bone, so that you may cut them with a knife." The cases which are spoken of under the name of "fragilitas ossium" appear to belong for the most part to the class of fatty or senile atrophy. Injury sustained in fracture is also a frequent cause of atrophy. Of this, the most extraordinary instance is that quoted by Norris,§ in which, after two fractures occurring at the same point, near the middle of the humerus, the whole bone disappeared, so as to leave the fore-arm "swinging hither and thither like a thong," and the arm shortened six inches. It is expressly stated, in the account of this curious case, that there was no open sore, and that the bone disappeared "by the gradual action of the absorbents." Mr. Curling‖ believes that the cause of atrophy after fracture may often, if not always, be found in injury to the medullary artery. Even allowing, however, that this explanation is plausible in some cases, there are others (not to speak of extreme instances like the one just cited) where it cannot apply. Such are cases of atrophy of both fragments, or of the bone in the neighbourhood of the fragments, while the latter are not so much atrophied.¶ Atrophy from inflammation is a condition illustrated by many morbid preparations, though it does not attract much attention in practice. It is merely the persistence of that degenerative change which leads to inflammatory softening; and probably many of the cases of atrophy after fracture should be referred to this head.

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* Op. cit. p. 5.

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* Humphry *on the Skeleton*, p. 8.

† See a preparation, no. 384, in the Museum of the Royal College of Surgeons, with its history.

‡ *Lect. on Pathology*, p. 409.

§ *Amer. Journ. of Med. Sc.* Jan. 1842, p. 39.

‖ *Med.-Chir. Trans.* vol. xx.

¶ See a preparation in St. Thomas's Hospital Museum, series c, no. 2. Here the atrophy is most marked in the *upper* part of the shaft; and the fragments included between the fractures (which were triple) are thicker than either of the portions of the shaft.

Connected with atrophy is the suspension of growth, occasionally, though rarely, met with, in which the epiphyses remain separate from the shaft of the bone; and it seems probable that injury to the epiphysal cartilage, in separations of the epiphysis, may occasionally give rise to shortening of the bone from suspension of growth between the shaft and epiphysis.*

Atrophy of bone is an affection which does not appear to be marked by any peculiar symptoms, or to admit of any special treatment. After injury to any part, the restoration of moderate functional activity as soon as it can prudently be recommended, the avoidance of any cause of pressure on the main vessels or those of the surface, and the choice of a suitable posture, with attention to the general health and nutrition, are the objects of a judicious treatment, irrespective of the condition of any particular part; and these measures are all that could be suggested to avert atrophy of the bone, even if it were known to be impending.

Spontaneous fracture has been mentioned repeatedly in the previous pages, in connexion with several morbid states, which may be thus enumerated in the order of their presumed frequency as causes of fracture: viz. senile atrophy, malignant disease, tumours of other kinds, including hydatids; the ulceration which accompanies necrosis, and, lastly, other kinds of ulceration. But besides these, cases of spontaneous fracture occur without known cause; sometimes in making a violent muscular effort, as in throwing a stone, or striking a blow; at other times in the most ordinary action, as in turning in bed, quiet walking, &c. Those which are caused by violent muscular efforts too nearly resemble the ordinary cases of fracture (particularly fractures of the patella) to call for any remark here; and the treatment of the fracture in the cases which occur during the progress of known disease is a matter usually of subordinate importance, and has been already sufficiently discussed in treating of the disease. I would merely add, that when the long bones are perforated by ulceration occurring around a sequestrum, the question of amputating the limb, or attempting to save it, will demand much care; and that, as a general rule, amputation will not be required in the upper extremity, nor should it be performed in the spontaneous fracture which rather frequently follows acute necrosis in children, unless the general health is evidently giving way; but in other cases of necrosis of the bones of the lower limb, and in almost all cases of ulceration not due to the separation of a large sequestrum, amputation as a general rule is indicated. When fracture occurs during the ordinary muscular exertion of every-day life,* and in persons not known to labour under any disease, various remote causes have been imagined, but none have been proved to be really efficient. The one most commonly admitted is syphilis; but, not to dwell on the fact, that the accident has occurred in many persons in whom the strongest reason existed for believing that no such taint was present, all that we know of the action of syphilis on the bones tends to show that (apart from ulceration and the separation of necrosed portions) it renders them not more but less brittle. The practical point of chief interest connected with such cases is, that there is no reason to despair of union, and that they should be treated in the ordinary way, with perhaps more than the ordinary care to avoid constriction of the soft parts.

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* Mr. Hutchinson lately exhibited at a meeting of the Pathological Society a radius shortened at the wrist to a considerable extent, while the upper part of the bone was natural. This was referred, with great probability, to an old separation of the epiphysis. The specimen is in the Museum of the London Hospital.

Wounds of Bone.

It is not necessary here to dwell upon wounds of bone, since the reader will find all that is practically important in the essays on Fractures, Gun-shot Wounds, and Injuries of the Head. Cases of incised wounds of bone without fracture do, it is true, occasionally come under the notice of the Surgeon. The chief interest in such injuries lies in the probability of diffuse suppuration (osteomyelitis) supervening, or of the separation of the periosteum, which is a common event in such cases, leading to necrosis. A reference to those sections will illustrate sufficiently the prognosis and treatment.

T. HOLMES.

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* Some interesting cases are to be found in Robert, *Conf. de Clinique Chir.* 1861; and many are scattered about in various books and periodicals. I remember seeing at St. George's Hospital a stout, florid young man who had fractured his thigh in simply walking across his room, without catching his foot or making a false step. It healed like any other fracture.

DISEASES OF THE JOINTS.

PART I.

DISEASES COMMON TO ALL THE JOINTS.

IN estimating the nature and importance of diseases of the joints, we have to bear in mind that we have no longer to deal with *single* tissues, as in the case of the bones, the muscles, &c., but with varied structures, distinct in their formation, their functions, and their pathology, but all so far united for a special purpose that disturbance of any one of them is sufficient to derange the harmonious working of the whole. The study of diseases of the joints, therefore, involves to a greater or less extent that of the affections of the *osseous system*, the foundation, as it were, of the articulations; of *cartilage*, *fibro-cartilage*, or *membrane*, interposed between the bones to play the part of the buffers in the railway-train; of *fibrous tissue* or *ligaments*, the coupling-chains; of *synovial membranes* with their *synovia*, the lubricating boxes and grease by which the friction is diminished; as well as of *connective* and *adipose tissues*, which serve as packing material to fill up the hollows. External to the joints, moreover, but still playing an important part in their mechanism, are various muscles with their tendons, as well as synovial bursæ, the pathological conditions of which in their relation to the joints cannot be entirely omitted or passed over.

When disease has advanced to a certain stage, all or the majority of these structures are likely to be involved, and an accurate allotment of the symptoms to their respective sources would be useless, even if it were possible. It is only, however, since the investigation of the diseases of the joints has been pursued in relation to their structural origin, that any precision of diagnosis has been arrived at, any really physiological system of treatment been adopted. The diseases of the joints are no longer lumped together under the vague denomination of "white swelling," but referred, with more or less certainty, to the tissues in which they commenced, and connected with the pathological changes which those tissues are found to have undergone. For this great improvement in the Surgery of the articulations we are mainly indebted to the acute intellect and philosophical spirit of our illustrious countryman Sir B. Brodie. The limits assigned to this essay are evidently insufficient to allow of any complete or comprehensive study of these varied diseases; no more than a sketch can be attempted; but that sketch, it is hoped, may be found sufficient for all practical purposes.

Anatomically all joints are not alike, being divided into the comparatively simple *synarthrodial* articulations, or those devoid of a synovial membrane, and the more complicated *diarthrodial*, in which a synovial membrane exists. Pathologically a similar distinction may to a certain extent be drawn, and the affections of the diarthrodial articulations may conveniently be separated from those of the synarthrodial, which will receive such notice as may be considered necessary in the latter part of the essay.

DISEASES OF THE SYNOVIAL MEMBRANES.

Physiological Anatomy of Synovial Membranes.

The synovial membranes, as we might expect from a consideration of their functions and composition, are the most prone to disease of all the structures which compose a joint, and even if not originally the seat of the mischief, they are very liable to become involved in its progress; it is with their affections, then, that we naturally commence. Though usually described as closed bags, they may rather be said to consist of short but wide tubes, the open ends of which are folded in upon themselves and firmly united, but with no very distinct margin, to the articular cartilage near its border or to its perichondrium; having previously, in some cases, invested a certain extent of the bone itself, and contracted connexions with its periosteal covering. Delicate in themselves, and composed of an *epithelium* as well as of *connective* tissue, in which we find vessels and nerves, in many articulations they are in close relation externally with strong fibrous coats, which give to them the appearance of considerable strength.

The synovial membranes present occasionally large adipose masses (*plicæ adiposæ*), the so-called "Haversian glands," which consist of an accumulation of fat-cells lodged in vascular folds of the membrane. These are seen best in the knee and hip-joints, and probably serve mainly as a soft packing material to fill up spaces which would otherwise exist. Connected also with the synovial membranes, and met with in almost every articulation, are its *vascular processes* (*plicæ vasculosæ*), presenting some resemblance in the arrangement of their blood-vessels to the choroid plexuses of the brain. They form flattened folds, and are usually situated near the point where the synovial membrane is united to the articular cartilage. Attached to the edges of these vascular processes are small projections of very irregular form, frequently devoid of vessels, and composed of fibrous tissue with occasional cartilage cells, and an abundant epithelium. The vascular processes in question appear to be active agents in the separation of the synovia, whilst their non-vascular projections are interesting pathologically from their supposed relation to the "loose cartilages" occasionally met with in the articulations. The chemical composition of the *synovia*, it may be mentioned, was found by Frerichs to consist of water, 94.8; mucus and epithelium, 0.5; fat, 0.07; albumen and extractive matter, 3.5; and salts, 0.9.

So constituted, synovial membranes are liable to inflammation, forming what is usually, though not perhaps very correctly, termed *synovitis*.

Synovitis.

The inflammation which attacks a synovial membrane may be of the ordinary character, or it may be modified by certain constitutional conditions. Common synovitis occurs, in many cases, as a local affection from the direct irritation of mechanical injury, or results from undue exercise and exposure of the joint to atmospheric influences; it may also be induced by disease which has involved the adjoining tissues. This form of inflammation is generally confined to a single articulation.

The constitutional conditions which modify the character of the inflammation may be more or less permanent, and even hereditary. Sometimes we find the patient presenting evident marks of *scrofula*, and the local disease sharing in the peculiarities of that affection; in other cases, and principally in the poorer classes, who are ill-clad and unduly exposed to variations of temperature, the *rheumatic* diathesis is apt to prevail; whilst in those who live luxuriously, the local inflammation may be preceded or accompanied by various symptoms of disordered digestion, indicating the presence of an unusual quantity of uric acid in the system, or the existence of the *gouty* diathesis. The constitutional modifications, on the other hand, may result from causes which are obviously temporary. A peculiar form of synovial inflammation, for instance, may occur unexpectedly after parturition, or following some operation, in those in fact who are suffering from what is termed *pyæmia;* or it may take place suddenly during the progress of urethral discharge, when it is distinguished by the name of *gonorrhœal rheumatism;* or, finally, it may manifest itself during the existence of *venereal* poisoning. In all these modifications of inflammation, it may be remarked, there is a considerable chance of the topical disease manifesting itself in more than one articulation.

It will be convenient to commence with a description of the *simple* form of inflammation of a synovial membrane, and its consequences, and afterwards to notice briefly the peculiarities presented by synovitis when *scrofulous*, *rheumatic*, or *gouty; pyæmic*, *gonorrhœal*, or *syphilitic*.

Acute synovitis. Synovitis may be acute or chronic. Acute synovitis, arising in the membrane itself from the causes already alluded to, occurs more frequently in adults than at an earlier period of life, in males than in females.

Pathological anatomy. The simplest changes which result from inflammatory action consist in increased vascularity of the membrane, especially of its plicæ vasculosæ, followed by increase in the amount of the synovia, and some alteration in its healthy composition. A little later, we find the products of inflammation either effused into the synovial cavity, mingling with and usurping the place of the normal secretion, or situated in the texture of the membrane and in the immediately contiguous tissues. The effusion into the joint-cavity may consist of serum, mixed with shreds of synovial epithelium, and a variable amount of organisable lymph, giving rise to false membranes connected with the walls of the cavity or floating in the secretion; some of the colouring constituents of the blood may also be present. In a large number of cases the inflammation is arrested before much mischief occurs; the vascularity of the membrane diminishes, the effused fluids are absorbed more or less completely, and the joint is restored to its original condition; or it may be left more distended than natural, and liable to fresh effusion; or a certain amount of thickening and loss of mobility may remain permanently.

In other cases, however, further changes occur within the joint; a process resembling granulation takes place on the surface, especially in the more loosely attached portions of the membrane, giving rise to villous or fringed processes, extending, perhaps, over the cartilages, which may still be sound beneath them. At the same time a similar action takes place on the outer side of the membrane, increasing the amount of thickening and consolidation of the capsule. If the inflammatory action still proceeds unchecked, the fluid effused into the joint becomes turbid, degenerative action goes on in the cells there present, and pus is formed, at first scantily, but afterwards in larger quantities; the other structures entering into the composition of the joint become involved in the diseased action; the articular cartilages are affected, ulcerous excavations extend through their substance, and the articular extremities of the bones participate to a greater or less extent in the disorganising process. The parts outside the joint-cavity undergo similar changes; degeneration takes place in their newly-formed materials, and abscesses arise there, communicating with the joint by ulceration extending through the capsule, or making their way to the surface by means of sinuses. The ligamentous structures become thickened or softened, or otherwise altered, so as, in some instances, to be no longer capable of holding together the bones, which may thus become completely or incompletely dislocated.

Symptoms. The leading symptoms are those of inflammation generally, varying in degree with the amount of synovitis present, with the cause inducing it, with the particular constitutional condition, and with the individual joint affected. The amount of inflammatory fever depends upon the character and extent of the synovitis, and the importance of the articulation, being generally most marked when the hip-joint is the seat of the disease. Locally, we have *pain*, usually of considerable amount, increased by any movement of the part, and often characterised by a feeling of distension. It may be noticed also that the pain in articular inflammations, as in those of some other organs, is not always referred to the region in which the disease actually exists. In diseased hip, for instance, the suffering may be experienced mainly in the knee, giving rise occasionally to mistakes on the part of the careless observer. There is *swelling*, varying with the amount of effusion into and around the joint, and taking the shape not of the articular extremities of the bones, but of the distended synovial capsule, modified by the degree of resistance afforded by the surrounding structures. *Fluctuation*, at least in the more superficial joints, is usually distinct, becoming less so if the disease is prolonged and the inflammatory products acquire a more solid character. *Heat* and *redness* are more or less evident, according to the situation of the joint affected, its proximity to the surface, and the degree in which the tissues external to the synovial membrane are involved. The *position* which is unconsciously assumed in acute articular inflammation is often characteristic of the affection and of the particular joint implicated. To alleviate suffering, the limb is placed in that position which at once gives to the joint-cavity its maximum capacity, and reduces to a minimum the tension of the capsule. M. Bonnet* has shown experimentally the physical effects produced after death by the distension of the synovial cavities with liquid forcibly injected into them, and the positions so assumed would probably be imitated when a similar distension is produced *rapidly* by disease. In other cases, however, that is, when the effusion has occurred more slowly, or when it can escape in consequence of rupture or ulceration of the capsule, the position of the limb is determined, to a great extent, by its weight, and the pressure exerted on it by surrounding bodies; by the necessity of fixing the joint as steadily as possible; and, ultimately, by the condition of contraction which the neighbouring muscles have been allowed to assume. It may often happen that it is difficult to determine the exact amount of influence due to each or any of these causes; but at any rate the effect produced, that is, the position assumed by the limb, is practically of great importance, for it is capable of maintaining or aggravating the disease at the time, as well as of giving rise ultimately to great embarrassment in the event of ankylosis occurring.

In the majority of cases of uncomplicated synovitis, the inflammation speedily subsides, the fluid is absorbed, and the part returns to its normal condition. In others, however, the joint remains somewhat swollen, the synovial membrane is thickened, and the mobility of the part diminished, whilst the patient is left very liable to relapse from exposure to any of the exciting causes of synovitis. Or the acute symptoms may simply diminish, and without any interval of restoration to health the disease may assume the chronic form to be subsequently described. In a certain number of cases, unfortunately, the inflammation, instead of subsiding, increases in severity, and the disease is no longer confined to the synovial membrane, the cartilages and other structures becoming involved, in the manner to be more minutely described hereafter. Such extension is marked by fresh and excruciating suffering, by painful "jumping" of the limb, as well as by crepitus on moving the joint, as the cartilages become destroyed, and is followed or attended in a large proportion of cases by suppuration.

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* *Traité des Maladies des Articulations*, par M. A. Bonnet, tom. i. p. 50.

Suppuration in a joint, however, occasionally occurs also *directly* as a consequence of acute synovitis. So long as the pus is contained within the synovial capsule, the symptoms are by no means unequivocal. We may *suspect* the formation of matter, if the inflammation continue to run high; if one or more rigors occur, followed by exacerbation of the pain and general suffering; and if the tumefaction increase and take on a more decidedly phlegmonous character which extends to the surface. The constitutional disturbance will now be great, the pulse rapid, and the character of the fever will be altered, assuming somewhat of a typhoid form. When suppuration has occurred within the joint, and the case progresses unfavourably, the parts around become speedily affected. Abscesses are formed in the surrounding areolar tissue; at first, perhaps, separate from, but soon communicating with, the articular cavity. The fibrous tissues become softened and yield, the skin gets implicated, and openings form communicating with the joint, and discharging a more or less unhealthy pus. When much disorganisation has taken place within the joint, the most favourable issue to which we can look forward is discharge of the matter, and union of the opposed articular surfaces. The health may now improve. The swelling subsides, the discharge diminishes, and at last ceases, the sinuses heal up, the joint-cavity is obliterated, being filled with newly-formed connective tissue, and the limb is stiffened or completely ankylosed. If, however, the constitutional powers give way, the patient may be worn down by the severity of the pain and profuse discharge; the removal of the source of irritation, by excision or amputation, becomes necessary, or where this is impracticable, life is at last extinguished.

Chronic synovitis may be simply inflammatory in its character, though it occurs more commonly perhaps as a modification of the inflammatory process, dependent on certain constitutional cachexiæ, such as scrofula, syphilis, gout, or rheumatism. In many cases the distinctive characters of each of these varieties are clear and well defined; and no difficulty is experienced in assigning the affection to its appropriate place. In others, however, the boundary-line is not always drawn with precision; and the Surgeon finds in these diseases, as in most others, that the definite descriptions necessitated in books are not always borne out in practice. Just as acute disease melts by insensible gradations into the chronic, so the constitutional modifications of inflammation are often imperfectly or scarcely marked. At the bedside of the patient, the Surgeon must work out for himself many details; and every case will still offer some special employment for his intellectual investigation. The author can only point out, as it were, the leading types; he who attempts more bewilders the reader instead of assisting him.

Acute inflammation of the synovial membrane, imperfectly treated, may by degrees assume the chronic form; or commencing without any great activity in its symptoms, the inflammation may pass into a chronic condition; in the latter case, however, the probabilities are very much in favour of the existence of some constitutional taint. The joint is sometimes much distended with fluid; and the synovial membrane itself, in protracted cases, loses more or less of its natural structure, is over vascular, and permanently thickened, or converted into a firm and gristly substance. The disease may gradually yield, or it may remain stationary in this condition for a considerable time, and then, under the influence of fresh inflammation, a new deposit of organisable material may take place, and the joint ultimately become totally disorganised.

The symptoms are much the same as in the acute form of disease, only far less severe in their character. The constitutional disturbance is comparatively little felt. There is swelling, sometimes to a considerable extent, more or less pain is experienced, and the movements of the joint are often very greatly impaired. In some instances a peculiar crepitus or crackling is felt, or a sensation is communicated to the hand as if a number of loose bodies existed in the joint, depending, perhaps, on effusion of plastic material into the cavity, similar to that noticed in inflammation of the bursæ and tendinous sheaths. The simple form of chronic synovitis, the form, that is, not connected with any constitutional taint, usually terminates favourably unless neglected, as is occasionally seen in the labouring classes, when attack after attack may occur till at last the joint is destroyed, or life itself sacrificed. In cases, too, of long standing, where great induration of the soft tissues has occurred, complete restoration to a healthy condition becomes at best difficult, and relapses into a state of sub-acute inflammation are of frequent occurrence.

Treatment of acute synovitis. The treatment to be adopted is partly general, partly local. If the inflammation runs very high, and the patient is strong and plethoric, it may be necessary to take blood from the arm; at any rate, a brisk mercurial purgative, followed by salines, with antimony, and perhaps with colchicum, will be advisable, or in some cases it may be expedient to place the system rapidly, but for a short time, under the influence of mercury. Where the patient is less robust, any blood-letting had recourse to should be local; and in all cases, though it will be desirable to keep the liver acting by combining taraxacum with the saline medicines, or by administering occasionally some preparation of mercury, violent purgatives should be avoided, on account of the disturbance to the limb which they necessitate.

The primary and essential condition of the local treatment is complete *repose*. Where the inflammation is of moderate extent, mere rest in bed, with the joint supported by a partially-distended air or water cushion, will be sufficient. Where the inflammation is severe, and danger of permanent mischief threatens, more decided mechanical support is required. The position to be adopted varies with the individual joint, but in all cases must be that which keeps no ligament, and no part of the synovial membrane, on the stretch, and which, in the event of ankylosis occurring, will allow the limb to be used to the greatest advantage. Supposing the articulation to have already assumed an improper position, it is better to put it right *at once*, even if the existing inflammation is acute; for in unnatural positions the different parts of the joint are kept in a state of undue pressure or of undue tension, either of which interferes with healthy nutrition, and so opposes the curative process. Under the influence of chloroform, the replacement can, at this time, be readily effected. The splint used should be well adapted to the limb, and be of *sufficient length;* in many cases it is absurdly short, giving no real rest to the joint, and allowing the weight of the parts below to drag upon the ligaments, and tend to produce deformity. In disease of the knee-joint, for instance, to give effectual support, the splint should extend very far up the thigh, and be furnished below with a foot-piece, to prevent the tendency of the foot to fall outwards or inwards, and so produce a corresponding twist of the affected articulation. The points here insisted upon are, of course, applicable not merely to cases of synovitis, but of all diseases of the joints, in which absolute rest is demanded.

Local depletion will probably be required to an extent determined by the acuteness of the inflammation and the vigour of the patient. If leeches are applied, it must be remembered that they act not merely by the abstraction of blood they give rise to, but also as derivatives, in consequence of the irritation produced by the bites. The application of a *few* leeches immediately over a *superficial* joint may tend, consequently, to increase the inflammation instead of diminishing it. In acute synovitis of such a joint as the knee, therefore, it is better to apply leeches freely, if at all, and at some short distance *above* the joint, so as to empty the distended vessels below. The same observations would, of course, apply, should cupping be employed instead of leeches.

After, or in slight cases in place of, the local depletion, various emollient applications may be used. As a general rule, warm fomentations and poultices are the most successful in relieving pain. Occasionally, however, cold is more grateful to the patient. Whichever is employed, uniformity of temperature is much to be desired; the joint should not be exposed to frequent changes, but the applications should be maintained constantly at or near the same standard. It is on this principle that wrapping the joint in cotton wool, or covering it with ointments which exclude the air, is often of service. If cold be applied, it may be used as directed by Dr. Esmarch,* in the form of ice contained in bags of vulcanised india-rubber (far preferable for many reasons to bladders), separated from the limb by a piece of lint. If this prove too heavy, a simple apparatus may be contrived, by suspending, at a suitable angle, from the cradle placed over the affected limb, a bottle containing cold water, in which a few threads are partially immersed, with their ends hanging out of the mouth of the bottle; these, by capillary attraction, will keep up a constant drip upon a piece of lint covering the inflamed joint, and the supply of fluid may be so regulated, by varying the number of threads, as just to compensate for the loss by evaporation, and prevent the rag from ever getting dry. Such an arrangement I frequently used with advantage at the Hospital for Sick Children, both in cases where acute inflammation already existed, and in others where its occurrence might be anticipated in consequence of operations. The cold should be maintained without intermission, as long as any abnormal increase of temperature exists, provided it appears grateful to the feeling of the patient.

Treatment of acute abscess of joints. If there is reason to believe that acute inflammation of the synovial membrane has proceeded rapidly to suppuration, the fact may be verified, at least in the more superficial joints, by the introduction of a needle-trocar. Supposing matter to be found, if left to itself, it will at last, after more or less resistance from the containing capsule, find its way through the muscles and tendinous structures to the skin; in doing so, however, it will dissect up and alter the relation of the parts, and so diminish their subsequent tendency to cohere; whilst the long and devious sinuses which are left will prevent the articular cavity from freely contracting and discharging its contents. It is better, therefore, when the situation of the joint admits of it, to evacuate the matter early by a free incision made in a depending position, so that the matter will flow out with the greatest ease. The opening in such cases is usually attended with marked relief; but fresh incisions may afterwards be made unhesitatingly, or the old wound enlarged, whenever any obstacle to the exit of pus shows itself. During this time the most perfect rest must be observed, and the limb maintained accurately in position by splints of sufficient length, moulded, if necessary, to the requisite form. Great attention must also be paid to the general health, and the strength supported as the activity of the inflammatory fever subsides.

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* *On the Use of Cold in Surgery,* New Syd. Soc. 1861.

If the matter within the joint decomposes without escaping freely, absorption of some of its putrid constituents may occur, showing itself by the irritative or typhoid character of the fever. In such cases, after providing as far as possible for the free evacuation of the pus, weak iodine injections may be used, not merely to modify the action of the secreting membrane, but also to improve the character of the matter by decomposing the products of putrefaction. With care and attention on the part both of the Surgeon and the patient, acute suppuration of joints from synovitis may fairly be expected to terminate favourably, especially in children; but as more or less stiffness of the joint must be expected, special attention should be paid from the first to the position of the limb, instead of waiting, as is sometimes done, till ankylosis has taken place, to remedy the deformity which has been allowed gradually to arise.

Treatment of sub-acute and chronic synovitis. Instead of giving rise to the formation of abscess, the acute inflammatory symptoms usually subside. As this change occurs, the antiphlogistic treatment is modified; some blood may still be abstracted by leeches applied directly over the part, and cooling applications may be used, or counter-irritation may be had recourse to, in the form of blisters, to produce a discharge of serum from the vessels of the skin. Blisters may be used earlier in inflammation of the deeper-seated joints than where the superficial articulations are implicated; for in the latter the small amount of intervening tissues allows the irritating action to be propagated to such an extent as sensibly to affect the synovial surface, acute inflammation of which may be again excited under the influence of too severe or too early a stimulus. In synovitis, therefore, of the superficial joints, blisters should not be applied too hastily, and when used may be placed some little distance above the inflamed spot; it is better also to employ a succession of "flying" blisters rather than keep *one* open by irritating applications. Following the blisters, or in place of them, various stimulating liniments may be used, or the part painted with concentrated tincture of iodine. As the inflammatory symptoms subside, in those cases especially where some thickening of the membrane has occurred, we combine a moderate amount of compression with our support of the part; this may be done by applying alternate layers of bandage and adhesive plaster with or without camphorated mercurial cerate next the skin in the way described as "Scott's bandage." Sometimes the bandage is starched, but care should then be taken, if any fresh outburst of inflammation occurs, that the bandage can be promptly removed, if necessary, by the patient. In some cases it is useful to employ splints made of cow-hide, softened in warm vinegar, moulded to the form of the joint, and fastened on the limb after having been lined with chamois leather. A variety of similar contrivances will probably suggest themselves to the Surgeon's mind.

If rest be a primary necessity in the acuter stages of inflammation, a time comes at last when this has to be discontinued, and passive motion of the joint substituted in its place. Care must be taken not to defer the change too late, nor yet to commence it too early; we begin to employ it with caution when we no longer find tenderness on pressure, or pain produced by gentle movement. In conjunction with these passive movements, friction with the hand, covered with starch, may be used zealously, though still cautiously, for gradually lengthening periods; or we may employ local vapour-baths, combined or not with shampooing. When the distension of the capsule has been considerable, and the joint is left relaxed, it may be necessary to wear an elastic bandage for a considerable period after apparent recovery. When thickening of the capsule has taken place, and the affection has been of a chronic character, time and gradual exercise of the limb, in addition to the measures which have been alluded to, will do much towards restoration of function, for in these cases the muscles of the extremity have become weak and wasted, and cannot be used freely till time is afforded for their renewed nutrition.

The treatment sketched out has been that proposed for disease of the synovial membrane itself; the treatment of those cases in which the bones and cartilages become involved will be alluded to subsequently, in the sections treating of diseases of those tissues.

Dropsy of joints. We occasionally meet with cases in which the synovial membranes are very greatly distended with fluid, whilst few or no other symptoms of inflammation are present. The affection, therefore, has been compared to dropsy of serous membranes, especially that of the tunica vaginalis testis forming hydrocele, and has received the special name of *hydrops articuli.* I have placed it, however, immediately after ordinary synovitis, because in almost all the cases where an opportunity has been afforded of examining the joint, the lining membrane has been found somewhat thickened and unusually vascular, especially in the situation of its vascular processes. The fluid differs from ordinary synovia, being transparent and of a yellowish colour, but presenting no appearance of "threads," though it coagulates on the application of heat; in fact, it closely resembles the fluid met with in ascites or in hydrocele. All synovial membranes are not equally subject to dropsy, which usually affects those of considerable extent, and in which the secretion is naturally abundant. It is most frequently found in the knee, sometimes in the elbow, very seldom in any other articulation. Hydrops articuli is scarcely ever a primary affection. It may follow an acute attack of synovitis, and is apt to recur in persons of weak and irritable constitutions, especially those in whom this condition is combined with the gouty or rheumatic diathesis, when once the membrane has been preternaturally distended. In such persons the immediate attack may be induced by exposure to cold or very slight violence, or even by some less obvious constitutional disturbance.

The effusion takes place very rapidly, and forms a tumour, whose limits are those of the synovial capsule. Its character may generally be easily recognised by the shape of the swelling and its ready fluctuation. There may be some slight symptoms of inflammation present; but usually, though the limb is somewhat stiff, it may be used with scarcely any pain, even from the first, and the parts external to the capsule show no traces of redness or œdema. From thickening of the joint due to effusion of plastic lymph, hydrops articuli is distinguished by the fluctuation which, as M. Bonnet remarks, is best recognised by placing one hand above and the other below the tumour; if they are placed transversely, the displacement of the muscles or tendons may be mistaken for the movement of fluids. From abscess of the joint, it may usually be distinguished by the condition of the soft parts around as well as by the constitutional symptoms, though it occasionally happens that the true nature of the effusion can only be determined by puncture with a needle. The prognosis in these cases is mostly favourable; at least, the other structures of the joint seldom become involved, though the disease itself may be difficult of cure and very prone to relapse, especially in cases of some standing.

Treatment. If any inflammatory symptoms are present, these must first be subdued by the ordinary constitutional remedies; which may be modified, if any gouty or rheumatic tendency can be detected, by leeches and fomentations, or by cooling lotions. When all traces of inflammation are subdued, and the affection has assumed the chronic form, the joint may be blistered, or painted frequently with a strong solution of iodine; this may be followed by compression by means of adhesive plasters and bandages, accompanied by stimulating and mercurial applications directly to the skin, for the purpose of promoting absorption. If the case is recent, under such treatment the effusion may be expected to subside; but it will still be necessary to support the relaxed membrane and protect the joint by wearing a laced or elastic knee-cap for an almost indefinite period.

In old and neglected cases, on the other hand, the affection resists all ordinary treatment, and must either be abandoned as incurable, or further and operative measures had recourse to, the most practicable of which are iodine injections, employed as in cases of ordinary hydrocele. Should it be considered advisable to have recourse to this plan, and the knee be the joint affected (as is most commonly the case), the spot selected for the puncture is that part of the synovial membrane which is situated above and external to the patella; the limb should be in the extended position, and the opening rendered valvular by pulling aside the skin before introducing the trocar, which should be only of moderate size. The fluid injected may consist either of a spirituous or an aqueous solution of iodine, the former being preferred by Boinet, who injected simple tincture of iodine; whilst Schuh,* who has employed this treatment successfully in three cases, employed one part of tincture of iodine to four parts of water. The quantity injected may vary from half an ounce to two or three ounces, the latter quantity being that used by Schuh. As much as possible of the fluid is allowed to escape, after being retained in the joint for about five minutes, and care taken to prevent any admission of air to the articulation. When the trocar is withdrawn, the cutaneous wound is coated with collodion. The immediate result of the injection is to produce a certain amount of inflammation; to prevent this from going too far, or from giving rise to suppuration, the limb must be retained in a state of immobility after the operation by means of a properly adapted splint, and the case watched carefully, so that antiphlogistic measures may be had recourse to if necessary. This treatment would only be adopted where all other means have failed, and much inconvenience results to the patient from the distended capsule. It is only suitable to cases of simple dropsy, those which are uncomplicated with diseased conditions of the bones and cartilages; but in proper cases it may produce a decided improvement of the condition of the part, or even sometimes a complete cure.

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* *Wien. Zeitsch.* N. F. vol. iii. p. 5.

Scrofulous synovitis. There is a peculiar form of slow inflammation of the synovial membranes occasionally met with in persons of strumous habit, which is sometimes described under the name of *gelatinous degeneration of the synovial membrane*, but which appears to be inflammation of a chronic character, modified by the scrofulous condition of the system. If we have an opportunity of examining the joint when the disease has advanced to a certain extent, the principal points which attract attention are, the thickening of the synovial membrane, and the gelatinous pulpy appearance which it presents. The vascularity of the membrane is increased, and the mass of its substance appears to be converted into a soft yellowish or light-brown gelatinous material, frequently of very considerable thickness. The articular cavity becomes diminished as the thickening extends upon the *internal* surface of the membrane; and as this extension goes on most freely in the loose synovial folds which surround the cartilages, these are often partially or completely buried and concealed beneath the new formation. A somewhat similar process occurs at the same time in the areolar tissue at the *outer* surface of the membrane, which becomes condensed and infiltrated with a corresponding pulpy substance. This gelatinous material, according to Mr. Barwell,* is the result of the same process, of what may be termed *granulation*, as that which occurs in acute synovitis; but in *healthy* inflammation the growth organises itself into a fibrous or areolar tissue, which gradually becomes more and more perfect; whilst in well-marked *strumous* inflammation it does not advance beyond the first form of crude cell-structure. Many gradations of course exist between the two conditions, which approximate or diverge with corresponding alterations in the patient's constitutional powers.

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* *On Diseases of the Joints*, p. 105.

The joint may remain in this condition for a considerable period, and then, under favourable circumstances, a process of restoration occurs, the new elements shrink or are absorbed, and the articulation is restored more or less perfectly to its former condition. More frequently, however, the disease makes further progress; the gelatinous thickening of the synovial membrane extends further over the cartilages, which become themselves secondarily affected in spots; though these spots are not, necessarily, at first, in *direct* relation with the altered membrane. The precise nature of the change which occurs in cartilage will be considered in the description of the diseases which affect that structure; it need only be said here that the cartilage becomes more and more altered and deteriorated at the points first affected, and that intimate adhesion soon takes place between the granulation-tissue which these points present and the corresponding growth from the synovial membrane. The change in the cartilage is attended or followed by inflammation of the bone on which it rests; the articular lamella gives way in places, a communication between the osseous tissue and the interior of the joint is formed, and granulations spring up from the inflamed membrane lining the cancelli, which join with those already existing within the articulation. In the mean time matter has most probably been formed, which may be retained within the articular cavity, or may make its way to the surface by means of sinuses.

If the disease still makes progress, the gelatinous growth continues to extend in an outward direction, or it degenerates in patches, giving rise to fresh formations of matter in its own substance or in the articular cavity; the constitutional powers now probably fail, the tissues of the joint, including the osseous, are still further destroyed, and amputation or excision is had recourse to, or the patient dies hectic. When, on the other hand, an improvement takes place, the new growth is directed inwards towards the articular cavity, which it tends to fill up. As the constitutional powers improve, the gelatinous material becomes firmer and more fibrous, it continues to contract, the cavity within it diminishes and is obliterated, the bones are united by a firm and solid substance, and the joint is ankylosed.

Symptoms. In assigning the name of scrofulous synovitis to this form of disease, we are guided in the first place by the constitutional condition of the patient, and by his presenting traces of what is commonly termed the scrofulous diathesis. In one set of cases this is marked by over-delicacy of the tissues, giving rise to a peculiar and easily recognised character of beauty; the nervous system is highly developed, the mind and body active; but there is an evident want of proportionate vital strength. The other form presents itself, on the contrary, with a coarse and superabundant condition of tissues, and is marked by the thick lip, the clumsy limbs, the heavy and lethargic aspect. In both conditions, which represent the *tuberculosis* and the *scrofulosis* of certain authors,* the nutrition is imperfect; inflammation, when it occurs, of a low, tedious, and intractable character. In many instances the immediate attack can be traced to some slight accident or other local source of irritation; in others no such cause can be discovered, the attack appearing to commence, as we may say, spontaneously. In both, however, it is characterised by a want of acuteness, even at its commencement; and in the latter case especially (and this marks the worst form of the disease) the swelling may for some time be almost painless. The disease makes its appearance most frequently in early life, at or before the time of puberty, though no period of life can be said to be absolutely exempt from risk of its occurrence.

The nature of the affection is most clearly recognised in those joints which are the most superficial. In its early stages it is characterised by stiffness of the joint, and the presence of a soft, elastic, colourless swelling, occupying the whole extent of the articulation. The absence of genuine fluctuation should prevent the disease from being mistaken for dropsy or abscess of the joint; the size and doughy feel of the swelling distinguish it from simple chronic synovitis; whilst its whiteness is opposed to the darker tint which is usually met with in malignant disease. The early stages of the swelling are usually accompanied with comparatively little pain, the disease in many cases being very insidious in its progress; in this respect, as well as in the shape of the swelling, which extends equally over the whole joint, instead of being specially manifest in the situation of one of the bones, differing essentially from strumous disease of the cancellous structures. If the progress of the case is towards recovery, the swelling ceases to increase, solidifies slowly, and gradually diminishes in size, the pain at the same time yielding, and the condition of the general health becoming much improved. Even if arrested in this early stage, a considerable amount of loss of free movement of the joint must be expected, and great care taken that no recurrence of the symptoms is produced by too early exercise.

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* See Dr. Jenner's Lectures, in the *Medical Times and Gazette*, 1860, vol. i. p. 259.

When the disease advances, the enlargement and stiffness of the joint increase; the pain, which was previously perhaps little more than a sense of aching or feeling of fulness, becomes more marked and altered in its character, being now described as a "jumping," "gnawing," or "starting" pain, and felt with special acuteness at night-time. This change may be considered as a sign that the disease is no longer confined to the synovial membrane; that the cartilages are becoming ulcerated, or rather, more strictly speaking, that the bone on which those cartilages rest is itself participating in the inflammatory action. Another symptom, which would indicate a considerable amount of destruction of cartilage, is the existence of crepitation on any movement of the joint by the patient himself or by the Surgeon. This crepitation, however, it should be recollected, may disappear or be masked at any time in consequence of soft and extensive granulations rising from the bones, and preventing their articular surfaces from rubbing on each other. The limb is now in danger of becoming rigidly fixed by spasmodic contraction of the muscles, causing it to assume positions varying in the different articulations, but all tending to produce future embarrassment, unless carefully watched and guarded against.

Before the disease has advanced to this point, in the majority of cases suppuration has occurred, either infiltrating more or less extensively the gelatinous mass, or limited so as to form circumscribed abscesses in its substance, or accumulated in the remains of the synovial cavity. If collected within the joint, there will be a general increase of the swelling, with throbbing pain, and perhaps fluctuation, attended by febrile disturbance to a greater or less extent. After a time the matter makes its way through the softened walls, and "pointing" takes place at spots determined by anatomical peculiarities referable to the individual joint; the sinuses so formed presenting subsequently large and flabby granulations. When the abscess is situated in the gelatinous mass itself, the increased swelling, instead of being general, takes place at any part of the mass which may happen to be the seat of the degeneration, and the opening forms at or near this point. In most cases, however, even when the joint-cavity was originally free, it becomes involved subsequently in the parietal abscess.

In proportion to the deterioration of the constitution will be the extension of the destructive action. The ligaments and neighbouring parts become softened and destroyed, the altered extremities of the bones are no longer firmly united to each other, and in this condition a partial or complete dislocation is occasionally produced under the influence of spasmodic muscular action; this dislocation being often attended with decided relief to the severity of the symptoms. If the constitutional powers improve, it is still possible for a process of repair and recovery to occur. The discharge in such cases diminishes, the openings contract and ultimately close, the skin resumes its natural appearance, while the swelling decreases and becomes more solid. The diminution in size of the joint continues till it becomes even smaller than it was before the attack, and the skin presents a peculiar puckered appearance around the articulation and at the seat of the cicatrices. The restorative process is of course attended with ankylosis, fixing the limb in the position it may have been allowed to assume.

Treatment. In our treatment we have to bear in mind that we are dealing with an affection originating in inflammation, but that inflammation modified and altered by the strumous diathesis. Our efforts consequently have steadily to be directed to the improvement of the constitutional condition; for if that is not effected, the chance of material benefit to the limb becomes but small. The general treatment of scrofula has already been described in this work, and need not be now repeated. Good air and plenty of it, warmth and light, attention to cleanliness and proper diet, are in all cases clearly inculcated. Where the tendency is to *scrofulosis*, the liver and bowels are usually sluggish, and require to be stimulated occasionally by tolerably brisk purges, combined with quinine; whilst in *tuberculosis*, purgatives must be given with caution, and be of the mildest character. In both cases, tonics, and especially cod-liver oil, are of service; though these tonics should be administered with judgment, and in relation to the presence or absence of inflammatory fever.

An essential part of the local treatment consists in the joint being kept in a state of perfect *rest*, by means of splints, which should be well and properly made, and constructed so as completely to prevent any motion of the limb, and at the same time admit of any topical applications which may be deemed advisable. As the chance of ankylosis occurring is more considerable than in cases of ordinary synovitis, the *position* of the limb becomes of even greater importance, though it is to be regulated on the same principles.

The splints may be made of leather or of pasteboard, or constructed of wire in the mode recommended by Bonnet and by Syme. If made of iron wire, a strong piece is bent to the shape of the limb, extending on both sides and united transversely to such an extent as to give the requisite degree of strength. The splint so formed is carefully lined with soft leather, or fitted with a kind of cushion, and will often prove highly useful. Too much attention can hardly be paid to the selection and adaptation of the splint in the first instance. If inflammatory symptoms are present, it may be necessary to employ a few leeches, or to use cooling or warm applications, as may seem expedient. As the inflammatory symptoms subside, counter-irritants may be had recourse to; these, however, should be employed with some degree of hesitation, and with the cautions previously pointed out as specially applicable to their action on the superficial joints. At the Hospital for Sick Children I became latterly more sparing in my use of them. Mr. Barwell,* however, strongly recommends the employment of the actual cautery in these cases, when the first symptoms of inflammation have somewhat subsided, but when some such action still continues, and enlargement is still going on. The iron is to be white hot, and applied in lines, about an eighth of an inch in breadth and three inches in length, parallel to the axis of the limb. Four such lines are recommended for the knee, two on each side of the patella, at least an inch apart; dry lint may be applied immediately after the cauterisation. The advantage of this plan, according to Mr. Barwell, consists not merely in its acting as a counter-irritant, but also in the pressure produced subsequently on the subjacent parts by the contracting cicatrices.

Where the disease is confined to the synovial membrane, and has assumed an entirely passive condition, evidenced by the joint being swollen and pulpy, but with entire absence of pain or tenderness on pressure of the part, or even on moving it, measures may be properly adopted to produce absorption of the indolent gelatinous mass. Such measures would obviously consist in *friction*, *passive motion*, and accurately applied *pressure to the part*. These means, as pointed out by M. Bonnet, may be freely adopted, but still with care and caution, and at once abandoned if symptoms of renewed activity in the disease show themselves. If any camphorated mercurial application is used to the part, with the pressure, in the way described as "Scott's dressing," it should be employed in these cases very sparingly, and in a very diluted form; the joint, too, should be examined frequently, to make sure that no fresh attack of inflammation has occurred. As the case progresses towards recovery, friction and passive motion are more freely used, and the treatment assimilates to that of ordinary chronic synovitis. Should suppuration take place within the joint, the matter must be evacuated by free incisions made in depending positions, followed subsequently by slightly stimulating lotions to the sinuses, and moderate pressure to the joint, which is still to be maintained in a state of perfect rest, as well as in a suitable position. When there is starting of the limb, or other evidence that the osseous and cartilaginous tissues are involved, issues may be made, or the actual cautery applied in the region of any tender spot. If the health give way, or the strength appear unequal to bear a long-continued discharge, and the circumstances of the case be such as not to admit of a prolonged use of all the constitutional remedies which may be desirable, amputation of the limb or excision of the joint will often become necessary. Should improvement, on the other hand, take place, and cure by ankylosis be effected, we must be careful to employ passive motion in due time to prevent ossification, and maintain the uniting material in its fibrous condition.

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* *On Diseases of the Joints*, chap. v.

Rheumatic synovitis. In the description of the ordinary form of synovitis, it was stated that this frequently arose from exposure to cold, or in connexion with other causes loosely spoken of as rheumatic. The synovial membranes and parts about the joints are also liable to suffer in a special condition of the system, by which the inflammatory process is materially modified, and which constitutes "rheumatism" properly so called. In acute rheumatism or rheumatic fever, the articular affection, although it may be severe and troublesome enough, is evidently dependent on constitutional derangement, culminating in a kind of inflammatory paroxysm assumed to be connected with excess of lactic acid. Unlike ordinary synovitis, the constitutional disturbance in this case is primary instead of secondary; and though a joint, when attacked, may display signs of severe and acute inflammation, yet these signs will often disappear with extraordinary rapidity, whilst other articulations become as suddenly affected. Acute rheumatism, therefore, being essentially a constitutional malady, falls naturally to the care of the physician, and its description must be sought for in works on medicine.

Chronic rheumatic synovitis; chronic rheumatic arthritis; rheu-

matic gout. The synovial membranes, as well as the other structures entering into the composition of a joint, are liable to a chronic affection, which has long been practically recognised, though varying names have been assigned to it at different times, or according to the class of joints which it happens to implicate. The term *nodosity of the joints* was the one proposed by Dr. Haygarth, whose attention was attracted to the hard swellings presented by the smaller articulations of the hands and feet, which at the present day more commonly receive the appellation of *rheumatic gout.* When the larger joints, such as the shoulder, the elbow, or the knee, are implicated, the disease is often termed *chronic rheumatism;* whilst a similar affection of the hip has been described by some authors as the *morbus coxæ senilis.* Dr. Adams of Dublin, however, in his valuable work on the subject, has arranged and classified the varieties of the affection, and proposed the term *chronic rheumatic arthritis;* a name which will, no doubt, henceforth be generally adopted. It will be seen that the disease implicates other tissues besides the synovial membrane; and, indeed, the changes which occur in the bones in these cases are so specially marked, that Mr. Barwell considers the morbid action to be in reality a rheumatic ostitis. The first obvious symptoms during life, however, are those in relation with the synovial membrane, and the earliest traces of disease after death have been found to be connected with the same tissue. Cruveilhier, Dr. Robert Adams, and Sir Benjamin Brodie, coincide in the opinion that a chronic inflammation of the synovial membrane is the earliest local result as far as the articulation is concerned; and I have therefore thought it best to notice the affection in the present section.

Chronic rheumatism is met with in two distinct conditions: as a palpably constitutional affection, implicating a multiplicity of joints, and either succeeding to rheumatic fever or following exposure to the usual exciting causes of rheumatism; and, secondly, as a local affection attributed to over-exertion, or injury, or arising without any assignable cause. The two sexes are, perhaps, nearly equally liable to be attacked; but Dr. Adams is of opinion that the larger joints, especially the hip, are more frequently affected in males, whilst females are more subject to the disease in the smaller articulations, such as those of the fingers; a fact which was originally pointed out by Dr. Haygarth. Though usually met with after middle age, chronic rheumatism is by no means confined to elderly people, for it has been seen in patients under the age of twenty, affecting simultaneously a considerable number of joints. Nor is it confined to any special rank; for though it prevails extensively among the labouring poor, it is also frequently met with in the wealthier classes, in those who have led indolent and luxurious lives, and in whom it is apt to assume a more decidedly gouty character. Though chronic rheumatism materially diminishes the *comfort*, it does not appear to shorten the actual *duration* of life, at least in those whose means allow them to be supplied with all requisite appliances; the very poor, however, are exposed to accidental or extraneous maladies, from the helpless condition to which they are reduced, and so with them the chances of life are unquestionably diminished. When once the disease has become established, its tendency undoubtedly is to progress, slowly but surely, until the joints affected become ultimately disorganised to a greater or less extent; sometimes the affection remains quiescent, or stationary, for an indefinite period; but very seldom indeed can any thing like a cure be anticipated, and then only when the case has been recognised and the treatment commenced before the disease has made much progress.

As far as the local affection is concerned, if we have an opportunity of examining the joint at a very early stage of the disease, we find redness of the synovial membrane, which becomes thickened and fibrous, whilst its fringe-like processes are much developed, and more vascular than usual, the internal surface of the capsule presenting somewhat of the appearance of a villous mucous membrane. There is also effusion of a moderate amount of fluid within the joint. At a later period, the fluid is absorbed; but the ligaments, which had been distended by the effusion, recover themselves but slowly, laying the foundation, perhaps, of the partial or even complete dislocations which are occasionally produced subsequently by the spasmodic contractions of the muscles which are apt to occur in certain stages of the disease. The capsules become very considerably thickened, and sometimes a bony deposit may be met with in their substance; in the interior of the joint, too, there may be found one or more of those foreign or extraneous bodies which are noticed separately in this essay under the head of Loose Cartilages. The articular cartilages by this time are probably affected; at certain points they assume a yellowish hue, and become fibrous. As the disease progresses, they are destroyed to a greater or less extent; sometimes presenting patches of dense bone, which are smooth and glistening; whilst at other times the cartilaginous tissue disappears entirely, and in its place we find a compact ivory-like bony material, which soon becomes highly polished under the influence of the attrition to which it is subjected. In the hinge-joints the porcelain-like material so formed presents linear furrows, resulting from the increased wear to which it is exposed in certain situations in the movements of extension and flexion; other articulations show analogous markings in the lines of greatest pressure. If fibro-cartilages are present in the joint, these structures do not escape; where the disease is well-marked and of long standing, the fibro-cartilages disappear completely, or, in certain exceptional cases, are converted into bone. In the hip-joint, too, the round ligament, and in the shoulder the tendon of the long head of the biceps, or the glenoid ligament, will often be removed by the process of absorption. The proper osseous structure becomes condensed beneath the articular surfaces, and bony vegetations are thrown out around them, forming buttresses which interfere with the movements of the joints by their mutual apposition. The shape of the articular surfaces is altered; the globular heads of the femur and humerus are flattened, and, as it were, crushed, their necks are shortened, and the cavities for their reception exhibit a corresponding change, resulting in varying amounts of deformity. These alterations have sometimes been mistaken for fracture of the neck of the humerus, or of the cervix femoris, in which bony union had taken place. It may be mentioned, too, that the abnormal condition is not always confined to the articular extremities, but may involve the shaft, or even the entire bone.

The general symptoms in these cases present no very special character. In some instances, as Sir Benjamin Brodie remarks, the disease appears to be connected with over-indulgence in animal food, and the patient experiences some of the usual effects of dyspepsia, such as a tendency to acidity and flatulence. In other cases, and especially, perhaps, where the larger joints are implicated singly, no particular constitutional derangement can be detected, and, indeed, it is remarkable to how slight an extent the general health is affected by the great amount of topical mischief which may have occurred.

The local symptoms are the most characteristic, and consist essentially of *pain, enlargement and ultimate deformity of the joint, rigidity or stiffness*, and a peculiar *crackling noise.* The pain experienced is principally felt at night-time, or when the joint is set in motion after a period of rest. The amount of pain, which is usually of an aching character, is far less than might be expected from the amount of structural alteration which occurs, and very different from that experienced in other affections of the articular ends of the bone implicating the joints. When only a single articulation is involved, the general suffering is not great, and the patient's condition is very tolerable; even when several joints are attacked, the amount of pain experienced may be only trifling, though it may become aggravated, especially under the influence of cold and humidity, and of atmospheric changes, to such an extent as to render rest almost impossible. The enlargement which occurs depends at first on increased effusion into the cavity of the synovial membrane; accordingly, in the larger joints, at any rate, the swelling is originally soft, and fluctuation may be detected. The synovial bursæ in the neighbourhood, both those which naturally communicate with the joint and those which are distinct from it, are sometimes affected, and by their distension contribute to the general enlargement. At a later period the swelling becomes hard, and osseous growths may often be felt connected with the periosteum and extremities of the bones, which lead to alterations in the form of the articular surfaces, and give rise to great and peculiar deformity, varying in the individual joints, but characterised in the smaller ones, such as those of the fingers, by the appearance of irregular knots; whence the term *nodosity of the joints*, proposed by Dr. Haygarth. These nodes continue to enlarge; the direction of the bones, perhaps, is altered; and when the disease assumes the constitutional form, fresh joints are attacked, without any relief occurring to those originally affected. It may be noticed, however, that there is little or no tendency to suppuration in these cases; abscess of the joint rarely, if ever, taking place. The amount of articular rigidity which occurs is peculiarly striking, rendering the affected joints practically useless, and simulating ankylosis, though true ankylosis rarely occurs, if indeed it ever does. In the advanced stages of the disease stiffness or even immobility of the articulations may be present, depending on the deformity which has occurred in the articular surfaces, and on the bony outgrowths which have formed; and where many joints have become affected, the unhappy patient may be confined to his bed in a state of utter helplessness. Though the muscles are not immediately implicated in the rheumatic affection, at some period of the disease, probably when the bone itself begins to suffer, painful spasms are apt to occur, contributing materially to the discomfort of the patient, and giving rise in some cases to the partial or complete luxations which are occasionally met with. When the joints have become rigid and practically useless, the muscles in the neighbourhood degenerate and waste. The sensation of decided crackling experienced in the movements of the joint is evident both to the patient and to the Surgeon, and is usually most marked when the articulation is first used after repose; it is especially noticed, therefore, in the morning. It depends upon the mutual attrition of the altered articular surfaces, and may be detected in most of the joints, but especially in the hip, and only disappears when complete rigidity has supervened.

Treatment. Dr. Haygarth, to whom we are indebted for our earliest notices of this disease, lamented the scanty means of treatment which he could suggest, and hoped, when time had been afforded for investigation by the profession, that fresh and more successful curative measures might be discovered. These hopes, however, have as yet been only partially realised; and in the advanced stages of the malady, when the joint has been essentially disorganised, we can scarcely anticipate much improvement. Our treatment, therefore, to be of real service, must be adopted at the commencement of the affection; at a later period we can but hope to mitigate the symptoms, to relieve the sufferings, and, at best, to retard the progress of the disease. In the early stage, when inflammatory symptoms are present, and any movement of the joint is attended with acute pain, it may be necessary to employ cupping or leeches, to keep the part at rest, and support it by means of bandages or splints. Care, however, must be taken not to prolong too far the period of immobility, for in these cases especially, want of exercise of the joint has ere long a deleterious influence on its structure. When the acuter symptoms subside, therefore, and rigidity increases, the patient should be encouraged to use the limb, to promote polishing and induration of the articular surfaces. Warmth and friction to the part are usually grateful. Flannel should be worn; and shampooing may be employed, or local douches or hot-air baths had recourse to. At certain stages of the affection counter-irritation may be used in the form of blisters or of painting with iodine; and in the nodosities of the fingers, the local application of a solution of iodide of potassium under oiled silk is sometimes of service; or cod-liver oil may be applied externally, as recommended by Sir Benjamin Brodie.

The general or constitutional treatment must be adapted to the individual case, and to the stage at which the disorder has arrived. Where any gouty element exists, where dyspeptic symptoms are present, and the case appears connected with too full a habit, great attention to the diet becomes of importance; stimulants should be abstained from; sugar, fruits, and raw vegetables avoided; and a moderate quantity of potash or magnesia be administered three or four hours after each principal meal. In other cases, however, the system appears impoverished rather than too full, and here it may be necessary to employ a better and more nutritious diet. In the earlier stages of sub-acute inflammation, it may be advisable to give a few alterative doses of blue-pill, combined, perhaps, with acetous extract of colchicum, and to administer Gregory's powder at night-time, with an active aperient at regular intervals. Respiration should be encouraged, too, by the use of the hot-air bath, or by taking Dover's powder, or other medicines to act upon the skin. At a later period, when some amount of change has occurred in the joint, the iodide of potassium may be administered in small doses, and continued for several weeks at a time, if it appears to suit the patient; for its action in these cases is somewhat uncertain. Various stimulating internal medicines may now be given, such as turpentine or guiacum; or cod-liver oil may be administered internally as well as externally; opiates also are usually of service for the purpose of procuring rest. Free action on the skin is still beneficial; warm clothing should be used; and, where circumstances admit, residence in a warm climate during the winter months materially increases the comfort of the patient. Warm bathing is usually attended with relief; the hot-air or Turkish bath may be employed with proper caution; and if practicable, recourse should be had to the mineral springs, such as those of Bath or Buxton in this country, Aix-la-Chapelle, Vichy, Ems, Wiesbaden, or Carlsbad on the Continent.

Gouty synovitis. The gouty diathesis presents some points of resemblance with the rheumatic; in fact the chronic form of alteration of the joints just described is often termed rheumatic gout. The speciality of the gouty inflammation, however, consists in the tendency to separate from the blood an inorganic material,—the urate of soda,—the deposit of which in and around the joint gives rise to more or less local disturbance. Gouty inflammation of the joints occurs in an acute or in a more chronic form. The acute form of gout requires no description here, as it is essentially a medical complaint, and is well and amply treated of in medical works. Where gout has assumed a chronic form, however, the local affection may predominate over the constitutional, and such cases may at times fall under the care of the Surgeon; they require, therefore, to be briefly noticed.

When gout first attacks a patient, the joint usually recovers its original mobility as the "fit" passes off; but when repeated attacks have occurred, the restoration becomes more and more imperfect, and at last the articulation loses entirely its capacity for motion.

Opportunities of examining the joint at an early stage are not common; but Dr. Garrod is of opinion that gouty inflammation is *invariably* accompanied by deposition of its peculiar salt. Unquestionably, as the disease advances, a deposit of the white, chalky-looking urate of soda takes place, in the substance of the ligaments and in the surrounding areolar tissue, as well as in the neighbouring muscles; or it may occur in the interior of the joint, thickening the synovial fluid, and studding the synovial membrane with small white masses; or in the substance of the articular cartilages, in the form of white spots, resulting from the presence of the crystalline salt in the hyaline structure; or, finally, the urate may be deposited in the bone and in the periosteum. Resulting from this deposit we may expect to find, sooner or later, the tissues themselves undergoing changes; the synovial membrane will be thickened and vascular; the ligaments and areolar tissue condensed; and the cartilages subsequently become softened and are removed, so that the articular surfaces of the bones are exposed and altered.

Whenever a joint is subjected to protracted attacks of chronic gout, it is certain to be permanently injured, either by becoming so rigid that its functions are practically destroyed, or from the formation of *chalk-stones* around it. Chalk-stones,—or *tophi*, as they are sometimes termed, from a Hebrew word signifying *concretion*,—vary much in their consistence; they may be soft and semi-fluid, or hard as the chalk from which they derive their name. Under the microscope they present bunches of needle-like crystals of urate of soda; and chemically they are composed of that salt, united with a certain amount of animal or earthy matter. A concretion taken from the metacarpus was found by Lehmann to contain—

Urate of soda	52·12
Urate of lime	1·25
Chloride of sodium	9·84
Phosphate of lime	4·32
Cellular tissue	28·49
Water, loss, &c.	3·98
	100·00

Chalk-stones are generally found in the smaller articulations of the hands and feet. They form protuberances, distorting and crippling the articulation, which approach the surface, till the skin over them is thinned, and allows their white colour to become visible. Dr. Watson relates the case of a gentleman who was in the habit, when at cards, of scoring the game on the table with his chalky knuckles.

It may be mentioned, as sometimes facilitating our diagnosis, that there is another situation in which deposits of urate of soda are even more commonly visible than in connexion with the joints, namely, in the cartilage of the external ear, in the form of little pearl-like bodies, varying in size from a split-pea to a mere white point, and situated usually about the fold of the helix. Out of seventeen cases in which Dr. Garrod detected gouty concretions, in seven they existed in the ears *alone*, in nine in the ears *as well as* around the joints, and only in one case were they found in other parts, but *not in the ear*. The gouty deposit, which is at first liquid, becomes harder in time from absorption of its fluid parts, and accumulates in many cases to such an extent as to render the joint completely fixed, whilst the neighbouring structures are also inconvenienced by the distension to which they are subjected. The mere presence of the salt in connexion with the joint does not appear usually to be attended with much irritation; after a time, however, inflammatory action, perhaps from a fresh gouty attack, may be set up, the integuments ulcerate, and a discharge, presenting the urate of soda mixed with blood-globules, takes place through openings which are often most troublesome to heal. These abscesses, however, it may be mentioned, appear sometimes to act as safety-valves, and their cure is followed by renewed attacks of gout, which had been suspended during the time they remained open. The diagnosis between chronic gouty affections of the joints and the chronic rheumatic arthritis already spoken of, is rendered easy when ulceration of the soft parts has occurred, and through the fistulous orifices chalky matter exudes, which can be determined by chemistry to consist of urate of soda. At an earlier period some uncertainty may exist; though the case may be considered gouty, when it comes on after repeated and manifest attacks of gout, and when the gouty diathesis is plainly marked; it may be proved to be so, if a puncture of the swelling with a needle allows of the escape of fluid in which the presence of crystals of the urate of soda is revealed by the microscope: for the existence of this salt forms the specific characteristic of the *gouty* affection, and is never met with in rheumatism or in chronic rheumatic arthritis.

Treatment. As the disease is essentially a constitutional one, the treatment must also be mainly constitutional, and consists in impeding the undue formation of uric acid, as well as in getting rid of the surplus amount of the acid already existing in the blood. For the first purpose the diet has to be carefully attended to; the dyspeptic symptoms relieved as far as possible; the secretions, especially that of the liver, regulated; and the strength of the patient supported in those cases where there is a tendency to loss of tone. To free the blood, we may administer occasionally small doses of colchicum, when the strength of the patient admits of it; but our main efforts are directed to increase the action of the kidneys and skin by means of salines and alkalies. The salines, to be of service in chronic cases of gout, must be given in small doses and very diluted; they should be taken on an empty stomach and some little time before food. The nature of the saline is by no means immaterial, and must be suited to the individual case, and varied occasionally according to circumstances. Time, too, constitutes a material element in the relief of the malady, and no hasty attempt at cure is likely to be of service. From these considerations, it is evident that the mineral waters, properly selected, offer many advantages for the administration of this class of medicines, as well from the state of dilution in which they are found, as from the greater chance of the patient continuing to take them for a sufficient time, while the mind is occupied and the attention diverted by the change of scene and hopeful statements there afforded. The external use of the waters can also be conveniently and usefully adopted. The spa to be selected must depend to a great extent upon the special characters of the individual case. In some, Carlsbad, Wiesbaden, or even Vichy, may be recommended; whilst in feebler cases, Aix-la-Chapelle, Teplitz, Wildbad, and Buxton are more likely to be of service. Where the debility is great, or after a course of other waters has been taken, the ferruginous springs of Schwalbach or of Pyrmont are often beneficial. For those who are prevented from going to a great distance, or who are desirous of feeling their way and seeing which spring is likely to suit them best, a trial of the carefully prepared factitious mineral waters of the spa at Brighton may often be deemed advisable.

It is, however, for the local mischief that the Surgeon may principally expect to be consulted. The local treatment will vary according as it is directed simply to relieve the stiffness and rigidity of the joints, or to alleviate any active inflammatory action which may have been set up, with or without the formation of abscess and production of ulceration. To relieve the stiffness, one topical application has, indeed, been already alluded to, in the form of baths of the mineral waters. Where these cannot be had recourse to, weak alkaline lotions, with iodide of potassium, may be applied to the joint under oiled silk, and gentle exercise of the articulation, with shampooing, friction, &c. employed with discretion. When a certain amount of low or chronic inflammatory action is going on in the ligaments and synovial membranes, small flying blisters are often useful, applied only for a short time, and with tissue-paper between them and the skin; in this particular condition, too, the internal administration of small doses of iodide of potassium is often of use. When acute inflammation occurs, as it may do when a new and severe attack of gout takes place in the seat of a chalk-stone, the amount of swelling which ensues may cause the cutis to give way, whilst the cuticle remains entire. It is better in these cases to avoid, if possible, making any incision; for the salt is deposited not simply in the cellular tissue or collected as a mass, but also in the actual substance of the articular cartilages, and cannot, therefore, be expected to be entirely or freely evacuated. Soothing applications are of most service; but it may be remarked, that where an opening occurs naturally, or is made by the Surgeon, the serious consequences frequently attendant on wounds of articulations are not to be expected, partly from the disorganisation which has occurred, partly also, no doubt, from the unimportant character of the joint which is usually involved. Severe operative measures are not called for in these cases. While the inflammation runs high, poultices and fomentations are of most service; afterwards, gentle pressure may be employed, and the sinuses which are left should not be irritated by probing or by stimulant applications, but allowed gradually to contract and ultimately heal. As already stated, when ulceration has once occurred, the case is almost invariably tedious, and may be rendered more so by too active surgical treatment.

Pyæmic synovitis. Acute synovitis, frequently leading to suppuration in the joints, is not a very uncommon consequence of purulent or systemic infection, and is met with in phlebitis, after operations, and in connexion with certain puerperal conditions, as well as in the progress of fevers, &c. For the description of the general condition giving rise to this complication, its symptoms, and its treatment, the reader is referred to the essay on PYÆMIA. It need only be stated here, that when this pyæmic condition exists, there is always danger of the joints, as well as of other parts of the body, becoming the seat of the local disturbance. Sometimes the attack is marked by the occurrence of violent pain, accompanied or followed by heat, redness, and swelling, affecting one or more of the articulations, which may present distinct fluctuation, provided they are superficially situated. In these cases more or less thin and liquid pus may be found in the interior of the joint, or, in some instances, diffused throughout the external areolar tissue. In other cases, however, large accumulations of pus may take place in the joint, suddenly or insidiously, unaccompanied by pain, and perhaps unsuspected during life. The number of joints affected may vary considerably. Only one may be attacked, or it may be difficult to find a single articulation which does not present pus when cut into. The inflammatory condition may remain confined to the synovial membrane, but frequently extends to the other structures, which become more or less disorganised. In a case of suppuration of the knee, following thecal abscess of the finger, Dr. Handfield Jones found increased vascularity of the synovial membrane, with villous projections from its surface; whilst the articular cartilage was ulcerated in places, the cartilage-corpuscles containing a greatly increased number of celloid masses in their interior, and the intercellular substance being fibrous, and deprived of its natural consistence.

The *treatment* in these cases is mainly directed to the relief of the constitutional infection, and its principles have been laid down in the essay on PYÆMIA. Locally, when we have reason to suppose that a joint is becoming implicated, it should be maintained in a state of perfect rest upon a splint, and the pain relieved by soothing applications. When suppuration has indubitably occurred within the joint, a free incision for the purpose of evacuating the matter is desirable, and the local treatment already recommended for abscess in the synovial membrane becomes applicable.

Gonorrhœal synovitis; gonorrhœal rheumatism. A milder form of synovial inflammation is occasionally met with in connexion with purulent inflammation of the urethra, or even with purulent ophthalmia. This complication appears to have been first described by Sir Benjamin Brodie, and usually passes now under the name of *gonorrhœal rheumatism*, though it differs in several respects from rheumatism, and is not necessarily connected with gonorrhœa. In these cases, during the existence of a urethral discharge, which may depend on gonorrhœa, or arise after the passage of a bougie, inflammation occurs in the synovial membranes of one or more of the joints, more particularly in the knee. Another peculiarity, which was pointed out by Sir Benjamin Brodie, is, that some form of ophthalmia very commonly accompanies or precedes the articular affection, or may alternate with it. All stages of gonorrhœa may present this complication, and usually no material change in the discharge is noticed, though sometimes it declines a little, when the synovial affection shows itself. The articular inflammation may last for a few weeks, or may continue for months or even years. It is very apt to involve one joint after another, and presents a decided disposition to relapse. The effusion which takes place is usually of serum rather than of lymph, and there is little or no tendency to suppuration; but sometimes it leaves the synovial membrane thickened, and the movements of the joint permanently interfered with. In some few instances the cartilages become involved, and permanent rigidity may be the result.

The immediate cause of this affection is still a matter of dispute. By some it has been considered to be connected with the gouty habit;[*] whilst Mr. Barwell considers it to be "in reality a slower form than ordinary of purulent infection, produced by inflammation of the prostatic veins."[†] He allows, however, that he has "no cases of dissection to prove this position;" for this affection differs from the ordinary form of pyæmic synovitis in at least one important respect, namely, that patients do not seem to die of it.

Treatment. The local treatment in these cases is much the same as that recommended in ordinary synovitis. So long as acute inflammatory symptoms are present, the usual antiphlogistic measures must be had recourse to; when effusion remains, free blistering should be employed, and "Scott's bandage" applied in those cases where there is thickening about the joint. At a subsequent period, friction, shampooing, local vapour-baths, or the use of the mineral waters of Buxton or of Wiesbaden, will probably be of service. The general treatment must also be conducted on the ordinary physiological principles. As the inflammatory excitement passes off, the iodide of potassium, combined with colchicum and opium, may be administered, along with occasional active purgatives; to be followed at a still later period by mild tonics. In the more chronic forms of the disease the greatest benefit will be derived from change of climate, including a residence at the mineral springs recommended for chronic rheumatism, with the use of the waters both internally and externally. The treatment of this affection by keeping bougies in the urethra, or by the administration of cubebs and copaiba, as once recommended, is hardly likely to be often had recourse to in the present day.

Syphilitic synovitis. The character of the synovial inflammation in some cases is modified by the existence of constitutional syphilis. Occasionally, as Sir Benjamin Brodie remarks, the synovial membranes of one or more joints assume a sluggish form of inflammation in the early stages of secondary syphilis, in connexion with papular eruptions. More frequently, perhaps, the joint-affection comes on at a more advanced stage of syphilitic infection, in connexion with affections of the bones, and especially of the periosteum. The inflammation in most cases is any thing but rapid in its progress or acute in its symptoms, though the nocturnal pains may be severe; and it is readily distinguished by its occurrence during the existence of other and characteristic symptoms of venereal blood-poisoning. Its constitutional origin is also marked by its tendency to affect more than one joint. The general treatment is naturally directed to the cure of the syphilitic infection. Where the patient's strength admits of the administration of mercury, this is the most, in fact the *only*, effectual remedy, and it may be used in the form of fumigations, in conjunction with the vapour-bath, in many cases where it cannot safely be taken internally. If mercury cannot be given, the iodide of potassium, combined with sarsaparilla or other medicines that tend to strengthen the patient, is often of the greatest benefit. Locally leeches are seldom required, or indeed admissible. Soothing applications may be had recourse to if the pain is severe, but rest of the limb by means of splints, and mild counter-irritation, are the remedies most frequently of service.

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[*] Johnson *on the Genito-urinary Organs*, p. 317.

[†] *On Diseases of the Joints*, p. 101.

"*Loose Cartilages*" *in Joints.*

We occasionally find in some of the articulations small movable bodies, which may be quite free or still attached to the walls of the joint by narrow pedicles, and to which the name of "loose cartilages" has been given. These bodies, which are usually met with in adults rather than at an earlier period of life, vary in their structure; some are comparatively soft, of a yellowish colour, and resemble masses of fibrin; in other cases, they are hard and glistening, rather white than yellow, and evidently composed of cartilage or fibro-cartilage, both on the surface and in their interior; frequently, too, they are partially, or sometimes almost completely, converted into bone. In many cases we find only one such body in a single joint, but it is by no means uncommon for two or three to be present, and occasionally they are met with in much higher numbers; Morgagni, for instance, discovered twenty-five smooth and polished globular bodies in the left knee of a woman who died of apoplexy. They vary considerably in size, being sometimes no larger than a barley-corn, whilst in other cases they may nearly equal the patella itself in their dimensions. When small, they are usually round or oval; when of considerable size, they may be elongated, flattened, or tuberous. The most common situation for these "loose cartilages" is the knee, but they are not confined to that joint; they have also been discovered in the other articulations, including even the hip, which was long supposed to be exempt from them.*

"Loose cartilages," in many cases at any rate, appear to take their origin from the small irregular projections which naturally exist in connexion with the "vascular processes" of the synovial membrane. These projections are often of extraordinary form, devoid of vessels, and united to the membrane by stalks of connective tissue. As has been already stated, they contain occasional cartilage-cells in the midst of their fibrous tissue, and are furnished with an epithelium, which is very thick in places. In certain abnormal conditions these processes increase in size and solidity, and may ultimately become detached from their connexions, so as to form separate bodies, which are perfectly free in the joint, or they may still remain connected with the parietes by an elongated pedicle. They are composed of "connective tissue with elongated nuclei, and coated with epithelium, and, though not always, contain a variable number of scattered fat- and true cartilage-cells; and they are not developed externally to the synovial membrane, but from an outgrowth of that membrane itself."† Occasionally we find imperfectly formed bone in the substance of the masses, derived probably from a further stage of conversion of the cartilage, or they may be bony throughout. According to Dr. R. Adams, these foreign bodies, which may be supposed usually to take their origin from the synovial membrane, are especially connected with the condition constituting *chronic rheumatic arthritis*, though it is not denied that they are seen in articulations which present no trace of that disease. It is probable, however, that the detached bodies found in joints may have more than one origin, for occasionally they have been seen without any evidence of organisation, appearing rather as fibrinous exudations, or as solidified precipitates from the synovia. Occasionally, too, portions of bone may find their way into the joint, which have evidently become detached from the articular surfaces. We also find occasionally in joints which have long been affected with chronic rheumatic arthritis separate pieces of bone deepening and extending the articular fossæ. These have been termed "*additamentary bones*" by Dr. Adams, who looks upon them as distinct formations resulting from the ossification of the structures in the immediate vicinity of the joint.

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* See *Archives générales de Médecine*, tom. xii. (1846), p. 363.

† See note to Kölliker's *Manual of Human Histology*, vol. i. p. 328.

A "loose cartilage" may exist in the joint for a length of time without producing sufficient disturbance to attract the attention of the patient, or to make him think that he is subject to any thing more serious than occasional rheumatic twinges. At last, however, in some movement of the joint, the foreign body slips between the articular ends of the bones, and then a violent and sudden pain is experienced, with inability to use the limb, which remains fixed in the position which it may have happened to assume at the time. The pain continues until the "cartilage" is dislodged by some means, when the immediate symptoms at once subside, though they are often followed by inflammation of the synovial membrane, accompanied with effusion. The character and violence of the suffering in these cases is peculiar, being often sufficient to make the patient fall, or even to occasion syncope. The attention of the Surgeon is now called to the part, and, on careful examination, he may succeed in discovering a firm extraneous body in the joint, which slips beneath the finger, to be lost beneath the patella or the tendinous structures above or below that bone. When the symptoms described have once occurred, they may be repeated at varying intervals; in some cases recurring on the slightest movement, and even during sleep, whilst in others they may be kept in check so as to give rise to but little practical inconvenience. If the attacks are frequent, however, the joint suffers sooner or later; the ligaments become relaxed, disease extends to the harder tissues, and the articulation is permanently injured.

The treatment to be adopted may be either palliative or radical. In the first place, however, any inflammation which may be present must be subdued, and any dropsical effusion got rid of by blisters or other appropriate remedies. When this has been done, a well-fitting elastic bandage, or a laced knee-cap, should be constantly worn to limit the movements of the joint and fix the loose body, if not permanently, at least to such an extent as to prevent it from slipping between the bones. In many cases this treatment is sufficient; but in some it is unsuccessful, and inconvenience is still experienced to such an extent as to require further operative measures to be had recourse to. When such is the case, the extraneous substance may be removed from the cavity of the joint, either by direct or by subcutaneous incision. Both these operations, however, are attended with a certain amount of risk, and should only be performed when the palliative treatment has been fully tried and *failed*, and the foreign body continues to give rise to active mischief. The foreign body, too, should be clearly movable, and capable of being brought to a part of the joint in which it is easily accessible. The patient should be prepared for the operation, both by appropriate diet and regimen, and also by the limb being kept perfectly at rest for a few days. The loose cartilage is then guided, if possible, to the outer and lower part of the joint, where it is most superficial. The next point is to fix the body securely, so that it may not slip out of the way during the operation; if this cannot be done effectually by the finger, the cartilage may be transfixed by a needle, and so secured. If the *direct* operation is the one adopted, the parts over the foreign body are now divided, and a sufficient opening made in the synovial membrane to allow the cartilage to be pressed out of the wound, without any unnecessary manipulation or disturbance of the joint. The edges are then accurately brought together by strips of plaster, and the limb kept at perfect rest on a splint; constant cold may also be applied to the joint, to prevent, if possible, the occurrence of inflammatory symptoms. In the *subcutaneous* operation, the cartilage having been securely fixed as before, a tolerably long tenotomy-knife is introduced through the skin, at some few lines' distance, and passed through the cellular tissue so as to make a subcutaneous incision into the joint. Great care must be taken in dividing the synovial membrane, that the foreign body does not slip aside, for which purpose it is better for the operator to secure it himself with one hand, whilst he makes the incision with the other. The loose cartilage is then pressed through the wound in the synovial capsule into the subcutaneous cellular tissue, and allowed to remain there, at any rate for some days, at the end of which time it may, if considered necessary, be removed altogether.

Sir Benjamin Brodie states in his work on the joints, that his experience does not enable him to determine which of these operations is to be preferred. According to M. Larrey, who refers to 167 published cases of removal of loose cartilages by operation, out of 121 cases in which the old or direct method was employed, 98 were successful, 5 doubtful, and 28 died; whilst of 39 indirect operations, 19 were successful, 15 failed, and 5 died. From this it would appear, as M. Larrey states, that extraction by either method is attended with decided danger; but that in the *direct* operation, the risk to life is greater than in the *subcutaneous*;

while, on the other hand, in the subcutaneous operation there is increased difficulty, and consequently less chance of success. On account of the difficulty which is experienced in getting the cartilage out of the joint into the cellular tissue without an undesirable amount of manipulation, Mr. Syme recommends another method, by which, he says, he generally succeeds without risk. This consists in "making a free subcutaneous incision through the synovial membrane and cartilage, and applying a blister over the part where it is retained."

Diseases of the Articular Extremities of the Bones.

The diseases of the joints which originate in the articular extremities of the bones are next in importance and in frequency to those which commence in the synovial membrane. It will not be necessary, however, to enter much into detail in treating of them here, as the morbid processes have been already described in the essay on Diseases of the Bones. A brief notice of these affections in their relation to the joints will therefore be sufficient.

Simple inflammation of the articular ends of the bones, and its consequences. The articular extremities of bones are liable to attacks of simple inflammation, which may result from injury, or depend on other causes. It may happen in the long bones that the disease has spread from the shaft, though such extension is by no means common, for inflammation of bone usually confines itself to the diaphysis, or to the extremities in which it may have commenced. The changes which take place resemble those which result from inflammation of other tissues, when allowance is made for physical differences of structure. In favourable cases restoration to a healthy condition occurs, or the inflammatory products may give rise to deposition of increased ossific material, leading to hardening and increased weight or size of the part. In less favourable cases suppuration takes place, which may be circumscribed, forming a *local abscess* in the articular extremity, or diffused in the cancellous tissue, as in *osteomyelitis*. *Local abscess of bone* is usually found in the head of the tibia, and, as a general rule, is recognised and remedied before the articulation is affected. If not, the synovial membrane becomes inflamed from time to time; and if the original mischief is still allowed to remain, the matter may at last make its way into the joint, giving rise to suppuration in that cavity. For a detailed description of the symptoms and treatment of *local abscess in the cancellous tissue*, as well as of *osteomyelitis* (which may in like manner lead to a discharge of pus into the nearest joint-cavity), the reader is referred to the essay above mentioned.

The inflammation may lead to the death of the whole or a part of the articular extremity, constituting *necrosis.* If the dead portion is limited in its extent and situated near the surface, the articulation may escape with little or no damage, and the sequestrum separate, or be removed by operation. Sometimes the necrosis is deep-seated, presenting then many points of resemblance with local abscess of bone, like which it may lead to destructive inflammation of the joint. There would be the same deep-seated pain, accompanied, perhaps, with rigors and low fever, and not yielding to the ordinary measures of relief for simple inflammation. In some of these cases the true state of things is only recognised when death or amputation allows the parts to be dissected; in others, however, a similar operation to that required for local abscess can be performed, the dead bone is removed, the pent-up matter evacuated, and the joint is saved. Sometimes the whole or the greater part of the head of the bone dies, giving rise, of course, to rapid destruction of the joint. Except in some of the deep-seated articulations, such as the hip, the introduction of a probe at once detects the presence of dead bone and its extent. As no hope can exist of saving the joint in such cases, its removal, when practicable, becomes the only course to be pursued. In necrosis affecting the very small joints, such as those of the fingers and toes, the amount of constitutional disturbance involved is so slight that we may wait, if we think it expedient, for the natural separation of the parts. In this way a sufficiently useful thumb or great-toe may be preserved, the superficial position of the articulation facilitating the removal of the dead bone.

Finally, instead of death occurring in obvious masses, the inflammation may lead to a molecular destruction and removal of the osseous tissue, by a process analogous to ulceration, which is termed *caries.* Caries of bone in the vicinity of joints may arise from simple inflammation; it occurs, however, so much more commonly as the result of scrofulous inflammation, that it is convenient, practically, to defer its consideration, or to merge it in the description of the latter form of disease, to which we now proceed.

Scrofulous inflammation of the articular ends of the bones. The scrofulous affection of bones which tends to implicate the joints consists for the most part of a low form of inflammation of the osseous substance, differing from ordinary inflammation in the nature of the exudation which is found in the bone-cavities; for tuberculosis, according to Dr. Black, occasions an increase in the fatty constituents and in the soluble salts, with a diminution in the lime-salts and in the organic matrix. Sometimes, indeed, there is actual deposit of circumscribed tubercle in the articular extremities of the bones (especially in the tibia), which may ultimately break down and find its way into the neighbouring articulation; or the tuberculous deposit may be diffused, in which case the joints are not so liable to be implicated. Both these forms of deposit are not improbably themselves the consequences, or the result, of low inflammatory action. The pathological changes involved in this action, so far as the bone is concerned, are described in the essay on DISEASES OF THE BONES; they need not be recapitulated here. Suffice it to say, that we find the affected bone more vascular than natural (at least at first), then light and oily, as well as unusually soft, so as to admit of being cut with a knife, the cancelli being dilated and filled with a jelly-like substance. This form of inflammation is much disposed to lead to caries. Caries, when affecting the articular extremities of the long bones or the cuboid bones, such as those of the tarsus and carpus, commences frequently in separate points of the cancellous tissue, which gradually extend, and so approach the surface. At last the periosteum itself is reached, and implicated; it becomes detached from the osseous substance beneath, which is left rough and worm-eaten on the surface, bleeding freely, and giving exit to a foul discharge, in which are contained particles of disintegrated bone. The soft parts around share in the diseased action. Serum and lymph are effused into the neighbouring areolar tissue, giving rise to a characteristic firm and elastic swelling; at a later period suppuration occurs, and the tissues are traversed by sinuses.

When the disease is situated sufficiently near a joint, the articular cartilages in the immediate vicinity of the inflamed bone become affected; their nutrient supply, as far as the osteal vessels are concerned, is interfered with; their adhesion to the bone is impaired, and they become fibrous and ulcerate, the change commencing usually on their deeper or attached surface; or portions of them may become detached, and ultimately be found loose within the joint. The synovial membrane participates in the inflammation, which may either spread to it from the diseased cartilages, or may affect it more directly by extension from the periosteum to that part of the synovial capsule which was described (p. 704) as investing the bone to a certain extent before it became united with the cartilage and perichondrium. It may be remarked that the affection of the articular ends of the bones sometimes assumes a peculiar form, which has received the name of "*spotted ulceration*," but which is probably a variety of the strumous disease. When this is the case, several pits or depressions, containing a curdy matter, are found in the articular surfaces, the cartilages presenting a series of defined orifices, corresponding to the pits in the bone, their intervening structure remaining frequently unaltered. The diseased action, which has been supposed hitherto to be confined to one side of the joint, now becomes diffused; the inflamed synovial membrane goes through the series of changes which have already been described under the head of Synovitis; the articular cartilages on the opposite side of the joint become affected, they speedily ulcerate, and the cancellous structure of the bone on which they rest is exposed. The disease gives rise to the formation of matter within the joint; but suppuration, it has already been stated, takes place likewise in the contiguous soft parts. As the case progresses, the matter makes its way to the surface, it may be directly, in the immediate neighbourhood of the joint, or forming tortuous sinuses, which open at a considerable distance, and give exit to a profuse discharge. When the long bones are affected, partial or incomplete luxations are apt to take place during the later stages of the malady. The disease may continue to progress till life ceases or the joint is removed; but sometimes, after dislocation has occurred, a reparative process takes place, healthy granulations arise in the bone, the synovial membrane goes through the changes tending to recovery, which have already been described, the discharge diminishes and ceases, ankylosis takes place, and the patient is left with a limb the utility of which varies much in different cases.

Scrofulous disease of the joints, commencing in the bones, if not so common as synovitis, is frequently met with in children of strumous habit, especially in those who have never thoroughly recovered from the depressing effects of some of the ailments to which they are subject. At the Hospital for Sick Children I was able, in a large proportion of cases, to trace the attack to the weakened state of health which had remained after scarlatina or measles. In early life the disease may affect indifferently the extremities of the long bones or the cuboidal bones; but when it commences after puberty, which is sometimes the case, it shows a decided preference for the carpal or tarsal bones. The disease is very insidious in its earlier stages, occasioning little pain or inconvenience; in children, the first thing which attracts the attention of the parent in most cases is "limping" when the joints affected are situated in the lower extremity, or unwillingness to use the arm when the upper limb is implicated. It is now noticed too, perhaps, that the child selects that position which will throw least stress upon some particular joint, or that he flinches when that joint is moved or pressed upon; and that the nights are somewhat restless. At this time little or no swelling can be detected; or if any exists, it is not diffused over the whole joint, as in synovitis, but situated over one of the bones which enters into its composition. As the disease advances, the joint itself becomes more decidedly implicated; the swelling increases, and now takes more the shape of the synovial membrane, though not so decidedly as in those cases where synovitis constituted the primary disease; there is usually effusion of serum and lymph into the areolar tissue over the affected bone, distending the skin, and producing a "white swelling." The joint is obviously stiffened, severe and painful startings of the limb show themselves, aggravated at night-time, and causing the child to cry out in his sleep, or to wake up with a shriek of pain. When this occurs, it shows that the articular surface of the bone is affected, and beginning to be laid bare to the joint; the 'starting' becomes specially marked, too, when inflammation has extended to the opposite bone, and when, consequently, the two inflamed and sensitive osseous surfaces are subjected to mutual pressure by spasmodic contraction of the muscles. This muscular spasm is originally induced by the osteal disease; eventually, however, it reacts upon that disease, which it aggravates by the forced and violent apposition in which it maintains the inflamed surfaces. Hence the great relief to suffering so often experienced when displacement of the bones takes place, under the influence of the morbid muscular contraction, after the ligaments and other retaining structures have become weakened. When this occurs, the mutual pressure of the inflamed bone-surfaces ceases, and from this period a curative process is often dated. Before this happens, however, matter has in all probability formed in or around the joint, and sinuses are produced, taking various directions in accordance with the anatomical arrangement of the part. If a probe is introduced, carious bone can sometimes be felt, but not always, in consequence of the irregular course which the sinuses often take. The integuments around the wounds are thin and discoloured, the discharge copious, watery, and unhealthy. The general health by this time usually shows strong signs of breaking up, the child becomes emaciated, hectic manifests itself, profuse night-sweats occur, and, unless relief is afforded, some vital organ becomes implicated, leading to the death of the patient.

Prognosis. The prospect of a successful issue to the case depends greatly on the treatment being commenced at a very early period, before the joint has become seriously implicated. It is most desirable, therefore, whenever a tendency to struma exists, that any expression of pain or tenderness about a joint, or any hesitation in the manner in which it is used, should be at once attended to, and a careful examination made by a competent Surgeon. In the wealthier classes this is usually done, and the progress of the case at this period can almost invariably be arrested, and a tolerably perfect cure insured. Even when the disease has arrived at a more advanced stage, when the joint has become implicated, and suppuration has taken place, care and perseverance on the part of Surgeon and patient will usually be rewarded ultimately by success; for these cases occur for the most part in early life, and "in children the plastic powers of nature are so great that recovery may take place, when in the adult any such hope can scarcely exist."* These observations, however, apply principally to the wealthier classes; for amongst the poor, who are struggling for their daily bread, early symptoms are generally unnoticed, and the disease has advanced to a great extent before surgical aid is invoked. Even if admitted into hospital, the patient can seldom be kept there long enough for complete recovery; moreover, the general health is apt to suffer, after a time, from the necessarily impure air of a sick-ward, and so the patient returns home, to be again exposed to the imperfect nutrition, the confined air, and the want of necessary comforts and appliances, which originally predisposed to the disease or accelerated its progress. Sooner or later, in all probability, he again applies to the same or some other hospital, in a still more advanced stage of the malady, from which he ultimately sinks, or has to submit to operation. If the prognosis, therefore, in the affluent classes is favourable, it is far less so among the poor and needy. Where circumstances are favourable, and the treatment commenced at an early period, a few weeks may suffice for recovery with a useful and movable limb; even when portions of the cartilage have been destroyed, the functions of the joint may still be preserved, though the time required becomes considerably prolonged. When the disease has advanced to suppuration, and sinuses have formed communicating with the joint, recovery can only be expected at the expense of ankylosis, and after the lapse of many months or even some years.

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* *Lectures on the Surgery of Childhood*, by Athol Johnson.

Treatment. If inflammation is present, we have always to bear in mind that it is of a low character, and controlled or modified by the constitutional condition: it is to the relief, therefore, of the constitutional condition that our treatment has to be mainly directed. In the essay on SCROFULA, and in the section devoted to *scrofulous synovitis*, the leading principles of the general treatment have been described. In this affection of the bones, as in the corresponding disease of the synovial membrane, we find two modifications of the systemic condition, representing respectively *tuberculosis* and *scrofulosis.* If mercurials are ever admissible in these cases (and except for the purpose of unloading the liver occasionally, I doubt whether they ever are), it is in the form of *scrofulosis*, with its sluggish tendencies, that they may be given, and then only with the greatest caution. The bowels are of course to be carefully regulated, and the state of the secretions attended to. When this has been done, tonics, especially the preparations of iron, form our sheet-anchor. In *scrofulosis*, the citrate of iron may be administered, in combination with *alkalies*, to assist the torpid condition of the liver and other secreting glands. In *tuberculosis*, an *acid* preparation of steel, such as the tincture of the sesquichloride, is often of more service, by correcting the tendency to profuse secretion. In neutral cases, or where a stimulant as well as a tonic is required, the vinum ferri is a useful preparation. I employed occasionally, at the Hospital for Sick Children, a syrup of the super-phosphate of iron with lime, undoubtedly with advantage, though whether the benefit derived was greater than that which would have been produced by other preparations of steel, I am not prepared to say. Where there is loss of flesh and evident defect of nutrition, cod-liver oil is most valuable, alone or in combination with other tonics. If iodine is given (and, without going so far as Mr. Syme, who asserts that "iodine and mercury are preposterous in such cases," I think that, with the exception of a few cases of *scrofulosis*, it is inadmissible), the syrup of the iodide of iron is probably the most advantageous form in which it can be administered. Whatever form of tonic may be selected, it must be given for a great length of time to be of service. As Sir Benjamin Brodie directs, the steel may be administered for three or four weeks at a time, and then suspended for a week or ten days; or some other tonic substituted in its place, if the first should have ceased to agree. Even after recovery has taken place, as the constitution is in fault, it is necessary to persevere with the general hygienic rules prescribed in these cases, if we wish to prevent a recurrence of the disease in the same or some other part.

The *local treatment* is to a great extent negative. The disease is one of defective power; local depletion, therefore, should be avoided, though occasionally a very few leeches may be employed to relieve rapidly any outburst of acute or sub-acute inflammation. Cold or warm applications can be used at these times, whichever may be most agreeable and soothing to the patient. Counter-irritants, whether in the form of blisters, issues, or the actual cautery, unless in exceptional cases, are more likely to do harm than good, by exhausting the patient. They are also objectionable for another reason: these cases usually occur in children, and repeated painful applications, with the frequent dressings subsequently required, induce fits of passion or of apprehension, which are lowering to the patient and injurious to the malady. In fact, in the treatment of children, it is of great moment for the Surgeon to acquire their confidence, to inspire them with a feeling of regard and affection; and this can never be done if his visit becomes frequently associated in their mind with pain and suffering. It may of course be necessary at times to have recourse to operative measures, or thorough examinations of inflamed and sensitive parts; but if practicable, these should be done *once for all*, and usually under the influence of chloroform. Is nothing, then, to be done locally? Efficient *rest*, with the limb in a proper position, here as in synovitis, is of the greatest moment. The limb should be wrapped in a thick layer of cotton-wool, properly secured, pasteboard or other splints adapted to the form of the joint applied, and the whole secured by gummed or starched bandages, which, without being at all tight, should extend so far as to embrace the joints *above* and *below*, as well as the actual one which is diseased. It is necessary that the limb should be fixed to this extent in order that the contraction of those muscles which arise at some distance from the articulation may be prevented, and the joint kept absolutely in a state of rest. Support, to a modified extent, should be continued to the part for some time after apparent recovery. It is also desirable that the splints should be so adapted as to allow exercise to be taken, whilst immobility of the joint is maintained.

When the case comes under treatment early, the Surgeon has only to *maintain* the limb in a proper position; but frequently it happens that the limb has been allowed to become distorted, and more or less fixed in its abnormal direction. In such a case it is better at once to restore the limb to its proper position, of course under chloroform, and, if necessary for this purpose, subcutaneous section of any resisting muscles may be freely performed. The limb may then be wrapped in cotton-wool, and secured in a suitable position by splints and gummed bandages as before. The expediency of this treatment depends not merely on the fact that ankylosis is to be expected (and for recovery by ankylosis to be desirable the limb must be fixed in a proper position), but also on account of its immediate influence on the disease. The painful startings are occasioned by pressure on the inflamed bone-surfaces; and so long as irregular pressure is maintained by the muscles in a state of spasmodic contraction, pain must be experienced and irritation kept up. Dr. Bauer has proposed to divide the tendons of the contracting muscles independent of any malposition, as a means of relieving the starting pains; and such a plan might not unreasonably be adopted if all milder means of relief should prove unavailing. Sir Benjamin Brodie has suggested the application of a moderate but constant extending force. For this purpose he employed a weight attached to a string, passing over a pulley fixed at the bottom of the bedstead, the other end of the string being secured to the limb, whilst counter-extension was kept up by straps, which prevented the body from slipping down in bed. A better application of the same principle, adapted to the lower extremity, has been described by Mr. Barwell,* in the form of a long splint, fitted with pulleys at each end, over which strings pass, the upper string being attached to the perineal band, fixing the limb above, and the lower one to a bandage secured round the ankle, the two strings being united in the middle to a strong india-rubber spring, which by its elastic force keeps up a constant tension on both of them.

When abscesses are forming, the splints employed must be so contrived as to admit of the application of poultices or other dressings. This may be done with the gummed bandage by cutting a kind of trap-door in the situation required. When the abscess approaches the surface, or when it is prevented from so doing by intervening fasciæ, it is advisable to make an opening, provided, of course, that the swelling really contains matter, and not serum. When an incision is made, it should be a free one, so as to allow of ready escape of the pus without unnecessary manipulation, and, if practicable, the most depending position should be selected, that the matter may drain out as fast as it forms. The sinuses which remain should be treated in the simplest manner: the application to them of irritating substances, and the frequent introduction of probes, are not merely unnecessary, but positively mischievous.

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* *On Diseases of the Joints*, p. 266.

If the case progresses favourably, and the sinuses contract and close, the treatment consists in the same local measures as those which have already been pointed out in the section on *strumous synovitis;* but the case may not progress favourably, and it may then become a question of resorting to *operation.* It has already been stated that in early life the limb may generally be preserved. With the children of the very poor, however, especially those in large towns, and, indeed, at all periods of life amongst those who have to gain their livelihood by labour, this question often arises: Is the chance, or even the strong probability, of ultimate recovery with a stiffened limb, after many months, perhaps years, of confinement and forced abstinence from labour, preferable to a more immediate recovery with the loss of the limb or joint, but with all the risks attendant on a grave operation? Every case must be decided on its own particular merits; but having this consideration in view, it is evident that a Surgeon is often justified in using the knife even where an operation is not absolutely necessary. When health is failing under the protracted confinement, suffering, and exhausting discharge, removal of the part often becomes advisable to *preserve life;* for, as has been already stated, where death takes place, it is usually from disease occurring in some internal organ. Now in scrofulous subjects, any thing which lowers the patient, or effects a drain upon his system, is prone to induce disease; the removal of the source of mischief, therefore, often saves life by preventing more important structures from becoming affected. On the other hand, it must be borne in mind that operations in strumous subjects are, in some cases, rapidly followed by the appearance of scrofulous affections of internal organs, which did not previously exist, or, at any rate, had failed to manifest themselves. In deciding the point, the Surgeon will undoubtedly be influenced by the position and importance of the diseased part, and the consequent severity of the operation required. To expedite the patient's recovery, he would promptly remove one or several of the tarsal bones, when he would hesitate about amputating the thigh, or excising the head of the femur.

The comparative merits of amputation and excision will be discussed hereafter.

The articular extremities of the bones are liable to *rheumatic inflammation.* In the essay on DISEASES OF THE BONES, the subject of *rheumatic ostitis* is described; and its relation to diseases of the joints is further discussed in the sections on Chronic Rheumatic Synovitis and Chronic Rheumatic Arthritis (p. 723), to which the reader is referred.

The joints may also suffer from syphilitic inflammation commencing in or extending to the bones. For this also the reader is referred to the essay on DISEASES OF THE BONES; and some further remarks on the subject will be found under the head of Syphilitic Synovitis (p. 735).

Rhacitic affections of the articular ends of the bones. The bones are materially affected in the constitutional derangement giving rise to rickets. This condition, which is sometimes supposed to be of modern origin, though the lines of Martial* would seem to show that it could not have been unknown in his time, is described in another part of this work.† It is only necessary to remind the reader here, that though the alterations which occur are specially manifested in the *shafts* of the bones, yet the articulations do not entirely escape. In the early stage of rickets the "knots" or swellings which take place in the osseous or cartilaginous ends of the bones are highly characteristic of the affection. At the anterior extremities of the ribs these enlargements are particularly obvious, affecting both the bone and the cartilage, and giving rise to an angular projection of the costo-chondral articulations. At a later period these articulations become much weakened, and permanent alteration of shape occurs. Sometimes the rib projects, and the cartilage is forced inwards; more frequently it is the rib which is driven inwards, and the cartilage is dislocated on its external surface, a connexion between the two being still maintained by ligamentous tissue. If the chest is examined, the extremities of the ribs will be found presenting a row of nodosities, the sides of the thorax are hollowed, the thoracic capacity diminished, and the function of respiration interfered with to a more or less serious extent. In the limbs similar nodosities are met with in the articular extremities of the bones, first appearing in the lower ends of the radius and ulna, as well as in the malleoli, and afterwards affecting the knees and elbows. As the disease advances, the shafts of the bones undergo the alterations described elsewhere, the bending of the diaphyses occurring more frequently, as well as at an earlier period, in the lower than in the upper extremities. The articulations participate more or less in the deformity, being often twisted in an opposite direction to the curvature which the limb has assumed. The ligaments yield, and incomplete dislocations are apt to take place. At the knee, for instance, displacement may occur outwards or inwards, resulting from a partial yielding of the articular extremities of the femur and tibia, itself induced by the unequal distribution of the weight of the body on the surfaces at the joint.*

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* Cum sint crura tibi, simulent quæ cornua lunæ,
In rhytio poteras, Phœbe, lavare pedes.

† See SURGERY OF CHILDHOOD.

The nature of the affection, when the joints are implicated, can scarcely fail to be recognised, in consequence of the rickety condition of other parts of the osseous system, and the period of life at which it occurs. The treatment in these cases is mainly constitutional, to remedy, if possible, the specific diathesis. Locally, it is advisable in most instances, when the articulations are disposed to yield and to become distorted, to apply mechanical support of such a nature as to counteract the tendency to displacement, and allow of exercise being freely taken. The articular deformity in this way is often relieved, and the results obtained are tolerably satisfactory.

Tumours of the articular ends of the bones. In the essay on DISEASES OF THE BONES an account of the new formations which occur in connexion with the osseous system will be met with. The tumours in question may be developed in or upon the articulating extremities, and, indeed, in the long bones the extremities are more subject to such formations than the shafts. If the articular ends are involved, the joints may evidently become affected either by their movements being mechanically interfered with, or, in the case of cancer, by extension of the disease to other structures, and consequent disorganisation of the articulation. The symptoms, therefore, produced by these formations, especially the malignant, present certain points of resemblance with those of other diseases of the joints, which may be briefly noticed. In some cases, the nature of the tumour for various reasons is obvious enough, and no difficulty arises in the diagnosis, but this is far from being generally, or even usually, the case; the rules, however, by which we are to be guided are laid down in the essay to which the reader has already been referred. The form of malignant disease most frequently met with is the soft or medullary, and according to Rokitansky it never commences, as a primary disease, within or upon the synovial membrane; the same remark applies with increased force to the cartilages, for the cartilaginous structures are sometimes found intact when every other part of the joint has been destroyed.* Whatever may be done in the case of innocent formations, in malignant affections the only chance of relief consists in amputation, which should be performed, if possible, so as to remove the whole of the affected bone. Even when this is done, the chance of permanent success is far from great; but amputation involving the retention of any portion of the cancerous bone is next to hopeless. Obviously, therefore, it is desirable to ascertain in which of the bones the disease began; and by attending to the point where the swelling first manifested itself, this can usually be determined.

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* See Bouvier *sur les Maladies chroniques de l'Appareil locomoteur.*

ABNORMAL CONDITIONS OF THE ARTICULAR CARTILAGES.

The articular extremities of the bones are protected by a thin layer of cartilage, one surface of which is firmly connected with the bone, whilst the other is free in the joint, except near the circumference, where it is covered by an extension of the periosteum, forming a special coat—*perichondrium*—which gradually terminates on the cartilage, without any well-defined border. It is to this perichondrium that the portion of synovial membrane which advances over the edge of the cartilage is inseparably united. Articular cartilage is composed of a finely granular or nearly homogeneous *matrix*, in which are imbedded the thin-walled *cartilage-corpuscles*, themselves containing two or three smaller or secondary nucleated cells. These corpuscles are numerous, and flattened near the free surface of the cartilage, parallel to which they are arranged; in the centre they are irregularly disposed and more scanty; whilst they assume a perpendicular direction towards the surface of the bone on which they rest, and here they become elongated. The surface of bone to which the cartilage is immediately attached is termed the *articular lamella*, though this, perhaps, might be more properly called the calcified lamella of articular cartilage, for it consists of permanent thick-walled cartilage-corpuscles, with the matrix or inter-cellular substance calcified, and is quite distinct from the true bone-structure immediately beneath. The articular lamella, like articular cartilage itself, contains no blood-vessels, and being interposed between the cartilage and the vascular bone-tissue below, we must suppose it capable of transmitting the elements of nutrition from the latter to the former, if we admit that cartilage can be nourished by the vessels of the bone. Mr. Barwell imagined, accordingly, that the articular lamella "consists of a series of very minute parallel tubes, which run in a wavy course from the bone to the cartilaginous surface."* Though this is probably not the case, and the linear arrangement, when it exists, is only the result of striation of the matrix before it calcified, yet there can be little doubt that the articular lamella is sufficiently permeable by fluids to allow readily of diosmose.

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* See Virchow, *Cell. Pathol.* Lect. xix.

The articular cartilages, when fully developed, contain neither nerves nor blood-vessels, and yet they are living tissues, though simple in their structure. Nutrition in them, as in the cornea, is not effected directly through the means of blood-vessels, but results from the conveyance of the nutrient materials taking place from cell to cell. The cartilage-cells retain their powers of reproduction; old cells disappear and are replaced by new ones, and so a round of nutritive changes takes place adapted to serve the wants and maintain the integrity of the tissue. The nutrient materials are obtained from the blood-vessels of the synovial membrane and of the bone; in both cases there exists a free vascular supply in close proximity to the cartilage, round the circumference of which are arranged the *plicæ vasculosæ* of the synovial membranes; whilst we find in the bones, beneath the cartilaginous surface (the *articular lamella*, however, intervening), vascular convolutions, dilatations, or plexuses, specially adapted for the reception of the blood and separation of its plasma.

The functions of articular cartilage are comparatively mechanical, intended as it is by its smoothness and elasticity to diminish friction and obviate the "jar" or shock to the bones, which would otherwise give rise to frequent fractures. Even for these purposes, however, it is necessary that a certain amount of vitality or nutritive power should exist, else the cartilage would gradually wear away in proportion to the amount of friction it has to sustain, and that we know is not the case; for if articular cartilages are somewhat thinner in the old than in the young, the change is not greater than that which is known to occur in other tissues of unquestionable vitality.

So long as the natural processes of nutrition and secretion, as well as the disturbed processes of inflammation, were attributed entirely to some mysterious action on the part of the blood-vessels, the healthy and diseased conditions of the non-vascular tissues scarcely allowed of explanation. But when we admit the nutritive power of the cell- or germ-constituents of the tissue itself, and consider the vessels as intended to bring supplies of prepared nutriment into sufficiently near relation to them, much of the difficulty vanishes. In perfectly developed articular cartilage we have permanent nucleated cells contained in their capsules and imbedded in an inter-cellular substance; and if we have no vessels in the cartilage itself, they exist in sufficiently close proximity to the tissue for the elements they contain to be within reach of the more direct agents of nutrition. Such an arrangement would be insufficient for organs in which intense action is going on; but for the passive cartilages, the blood-vessels of the bones on which they rest, and of the synovial membranes which surround their circumference, afford a sufficient supply of nutritive material for the cartilage-corpuscles to maintain the integrity of the tissue. If this supply is interfered with, if the circulation in the bone or in the synovial membrane is disturbed beyond a certain point, we can understand that the nutrition of the cartilage should be prone to suffer, and so we find this tissue very liable to be affected *secondarily* in consequence of inflammation, common or specific, occurring in the synovial membrane or in the articular extremity of the bone. Its nutrition, however, may also become abnormal, directly or primarily, from some disturbed action in its own elements, and we have disease of the cartilage, attended with great alteration of structure, where the neighbouring tissues exhibit little or no sign of disease.

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* Barwell *on Diseases of the Joints*, p. 9.

Articular cartilage is described even at the present day, by authors of high standing, as not being susceptible of inflammation. If this means that cartilage, possessing naturally no vessels, cannot present *all* the symptoms which characterise inflammation of ordinary tissues (amongst which redness from increased capacity of the vessels is one of the most obvious), the statement is true enough, and cannot be denied. But if we look upon the essential character of inflammation as consisting in an excessive local change of material, and that change resulting at once in increased *loss of substance* and increased *production of substance*, the two actions going on at the same time though in ever-varying proportions, it is difficult to assert then that articular cartilage is not subject to such disordered conditions of nutrition as may fairly be called *inflammatory*. For articular cartilage, though drawing its nutrient supplies from foreign vessels instead of from vessels of its own, is so far under the influence of the laws which regulate vital tissue as to be at once capable of maintaining its own status during health, and of undergoing changes, many of which are analogous to those termed inflammatory, in a state of disease. Thus cartilage will maintain itself in its usual condition during a long life; it may be hypertrophied or atrophied; it may degenerate, may ossify, or perish, but it may also ulcerate, and probably suppurate.*

Hypertrophy. Articular cartilages, it is said, are occasionally found to present an increase in their substance without any obvious change in their actual texture. Such a condition, however, appears to be very rare; for, as a general rule, when the cartilage is thicker than natural, the tissue is soft and spongy, with a tendency to break up into fibres, exhibiting, in fact, obvious marks of disease.

Atrophy. Simple wasting of the tissue in cartilage occurs more certainly than simple hypertrophy. In advanced life, and especially in those joints which are subjected to the greatest amount of pressure, such as the hip, we find the cartilages gradually thinned, their structure in other respects remaining healthy. The process is, of course, a slow one, advancing gradually with age, and constituting, in fact, little more than a sign of natural decay. True atrophy, in most cases, affects the whole surface of the cartilage; but a partial thinning is met with in comparatively early life, accompanied usually with sufficiently marked traces of previous disease to distinguish it from simple wasting.

Gouty deposits in cartilage. In old gouty subjects we sometimes meet with a peculiar change in the articular cartilages, resulting from the deposit in their substance of urate of soda. This salt is found not merely on the surface of the cartilage, but also in the inter-cellular substance, through which it is diffused, sometimes to such an extent as almost to supersede the proper cartilaginous structure, which then presents the appearance of a chalky mass. The predilection exhibited by the gouty material for this tissue is further shown by the frequency with which it is deposited in the cartilage of the external ear as well as in the articular cartilages.

Fatty degeneration of cartilage. In advanced life, in joints which have long been disused, and under other circumstances unfavourable to healthy nutrition, articular cartilages sometimes undergo a process of degeneration corresponding to the analogous affection of the cornea, which passes by the name of *arcus senilis.* In such cases we find the whole or part of the articular surface presenting a series of fibres, free at one extremity where they project into the articulation, and attached at the other to the remaining cartilaginous tissue, exhibiting, indeed, somewhat the appearance of velvet. The cartilage is often thickened and pulpy, and much softer than natural, or it may appear rough and fibrous.

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* See Weber *über die Veränderungen der Knorpel in Gelenkkrankheiten,*—Virchow, *Archiv,* Januar 1858.

In this degeneration the cartilages may be said to be ulcerated, and, indeed, this affection is included by Dr. Redfern in his most valuable treatise *On the Anormal Nutrition of Cartilage*, under the general head of ulceration; for, in truth, the tendency to disintegration, degeneration, or destruction, which forms one of the characteristics of inflammation generally, is especially marked when the cartilages are the tissues affected; and so we find in the cartilages, even when involved in acute disease of the joints, the softening material exhibiting a plentiful admixture of oil-drops. The degeneration we are describing, however, seems to differ as well in the class of cases in which it occurs as in the fact that, while the cartilage-corpuscles and their contents increase in size, instead of a multiplication of secondary cells, oil- or fat-globules make their appearance in the interior of the cartilage-corpuscles, increasing till they occupy the whole of these cavities, which they distend, and so contribute to the soft or pulpy condition of the tissue. The degeneration extends likewise to the inter-cellular substance, which becomes striated, or separates into fibres.

Ossification of cartilage. Many cartilaginous structures have a natural tendency to ossify as age advances, and so we find the costal cartilages usually, and the thyroid and cricoid cartilages occasionally, undergoing this change, which represents in them a form of degeneration or decay. The articular cartilages, on the other hand, are by no means prone to such a transformation; for, when the developmental ossification is completed, any further tendency in this direction appears, as a rule, to be permanently arrested in the cartilage which remains beyond the articular lamella. Under certain circumstances, however, articular cartilage becomes converted into bone. This change, occasionally met with in the aged, is obvious enough at times during the progress of *chronic rheumatic arthritis;* for in joints suffering from that affection, the place of the entire cartilage may be occupied by a peculiarly dense kind of bone, in which the Haversian canals are filled with calcareous matter; or portions of the cartilage may be replaced by this ivory or porcellanous material, which remains on a level with the remaining cartilaginous structure.*

Ulceration of cartilage. It has been already stated, in accordance with the opinion of Weber,† that articular cartilage, like the cornea, is very liable to an altered condition of nutrition, which may fairly be called inflammatory; a condition which shows itself principally in the form of ulceration. The researches of Goodsir and Redfern, followed by those of still more recent authors, have shown satisfactorily that the changes in ulceration arise immediately from a vital alteration occurring in the cartilaginous structure itself, and that the influence of the neighbouring blood-vessels is only indirect or secondary. When the disease is peculiarly active, almost the whole of the cartilage may disappear, a few isolated patches, which are usually reddened, alone remaining. In other cases, the cartilage is softened and abraded; or it appears as if portions of it had been scooped out, leaving smooth pits or depressions. Ulceration usually begins on the free surface of the cartilage; it may commence, however, on its attached surface, or even in its substance.

If we examine the changes as they occur on the free surface after synovitis, we notice that the colour of the cartilage is altered in spots, which either rapidly become holes, looking, to use Sir Benjamin Brodie's expression, "as if they had been cut out with a chisel," or the spots assume a fibrous aspect, becoming gradually excavated, so as to form pits or depressions with fringed margins. Such a condition may be found destroying the cartilage extensively, and even laying bare the bone, without the presence of any membrane. In many cases, however, and especially in scrofulous synovitis, we find a thickened or newly-formed vascular membrane extending from the diseased synovial capsule over the cartilage. Such an extension, indeed, may occur without any ulceration resulting; or even when the cartilage is affected, the excavations are not at first necessarily in connexion with the membrane, for they may be found in situations to which the membrane has not extended. As the disease goes on, however, the cartilage, according to Mr. Barwell‡ (in his description of the changes occurring after strumous synovitis), slowly undergoes a transformation into a form of granulation, between which and the similar material growing from the synovial membrane adhesions form, resulting at last in absolute continuity. If the ulceration extends deeply, the bone beneath participates in the disorder, its vascularity is increased, and at last the cancellous tissue becomes inflamed. The articular lamella crumbles, or gives way in masses, carrying with it portions of cartilage, which may still be comparatively sound; and the granulations which spring from the exposed cancellous tissue unite with those of the synovial membrane. When the disease originates in the bone, and extends to the cartilage, the first process, according to Mr. Barwell, is one of simple degeneration, followed usually by true inflammatory ulceration. A portion of the cartilage, losing its nutrient supply, degenerates or perishes, and is detached with its articular lamella from the inflamed surface of the bone, whilst the surrounding portions of cartilage undergo the changes described as occurring in ulceration after synovitis. Inflammatory ulceration of the cartilages, unaccompanied with disease of any other joint-tissue, may possibly take place, though cases of it are not easily met with; degeneration, on the other hand, being of comparatively frequent occurrence.

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* See the section on Chronic Rheumatic Synovitis and Arthritis.

† See Weber's paper in Virchow's *Archiv* for January 1858.

‡ Barwell *on Diseases of the Joints*, p. 113.

If we examine the minute changes which have occurred in the cartilage during this process of ulceration, we find that they consist primarily or essentially in enlargement of the cartilage-corpuscles, with greatly increased production of the cell-structures contained within them; and this is attended or followed by alterations affecting the inter-cellular or hyaline substance. In proportion to the activity with which the disease advances, are the changes which the cartilage-corpuscles present. They become rapidly distended, the cell-structures within them augment and undergo development; their walls give way, and their contents are discharged into cavities formed in the tissue itself; or they burst upon the free surface, their cell-contents mixing with the organic substances contained within the joint, and probably forming pus, while the emptied corpuscles give rise to the depressions there met with. The nearer to the seat or focus of the disease, the greater the endogenous growth. Instead of two or three nucleated cells, the corpuscles may contain an almost indefinite number of younger cells, or structures presenting all the characters of pus-globules. Dr. Redfern considered that "pus had never been shown to be formed from the substance of diseased articular cartilages, nor from effusions into their texture;" but Weber* appears to have demonstrated that suppuration really does take place in articular cartilage. As this augmented action goes on, decay and degeneration manifest themselves, and so we find perishing cell-structures mixed with granules and drops of oil in the ulcers. The increased productivity of the cartilage-corpuscles is attended with alterations in the inter-cellular substance. When the diseased action is very acute, the hyaline material is rapidly disintegrated and destroyed; whilst in more chronic cases it is split into bands or fibres of varying sizes, in the midst of which are sometimes found gelatinous masses, supposed by Dr. Redfern to be the changed contents of the cartilage-corpuscles.

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* Virchow's *Archiv*, Jan. 1858.

When the cartilages have been extensively destroyed and the cancellous bone-tissue on each side of the joint exposed, repair, if it occurs, takes place by granulation-tissue uniting the opposing surfaces, and producing ankylosis in the manner already described. Or the ankylosis may be incomplete, portions of cartilage still remaining unaltered. In slighter cases, a natural cure may occur after ulceration has gone on for some time, and affected the cartilage to a considerable depth. This takes place, as Dr. Redfern points out, "by the formation of a fibro-nucleated membrane from the substance of the cartilage, without the occurrence of any new exudation." Occasionally we find a patch of ivory deposit occupying the place of some portion of the cartilage, or there may be simply a scar left, marking the place where the ulcer had existed. To complete the sketch of the changes which this tissue undergoes, it may be stated that "in cartilage malignant affections are so rare, that it is usually assumed to be altogether insusceptible of them."* For this insusceptibility Virchow gives reasons, founded on his views of the transference of the infection, by means of morbid juices, to the anastomosing elements in the neighbourhood.

Symptoms. Lesions of cartilage may occur primarily or secondarily. As primary affections, we frequently find after death well-marked "ulceration" where no symptoms had been noticed during life, excepting perhaps, occasionally, a certain amount of "crackling" or "grating" in the joints. These cases are of course chronic in their character, and the affection is of the nature which has been described under the head of degeneration. True "inflammatory" ulceration is almost invariably secondary, the consequence of inflammation, common or specific, occurring originally in the synovial membrane or in the bone. This affection may be acute or chronic in its progress. Mr. Lawrence* relates the case of a patient who died after venesection, in whom, as he believed, complete destruction of the articular cartilages of the femur and tibia took place in four days. In most cases, however, it is much slower in its progress; and in some, especially in old diseases of rheumatic origin, it may be extremely chronic in its character.

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* See Chance's edition of Virchow's *Cellular Pathology.*

Degenerative ulceration of cartilage is attended with no marked symptom, gives rise to no pain. Is pain produced by "inflammatory" ulceration? The deservedly great authority of Sir Benjamin Brodie for a long time connected with ulceration of the cartilages those severe pains which are increased at night-time, aggravated by any motion, and attended with involuntary startings of the limb. The fact, however, that no nerves can be discovered in articular cartilage, even with our present improved powers of investigation, renders such a view almost inadmissible, unless we conclude that our means of investigation are still too defective to warrant our placing trust in them. In his last edition, however, Sir Benjamin Brodie avows that he is "inclined to the opinion that the increased sensibility in these cases is in the bony plate beneath the cartilage, rather than in the cartilage itself; and that the presence of severe pains, with involuntary startings of the limb, is always to be regarded as a sign of the bone partaking of the disease." We may assume, then, that disease of articular cartilages is attended with no distinctive or characteristic symptoms (if we except the "crackling" on motion, mechanically attendant upon a loss of smoothness of their surface). In cases of disease commencing in the synovial membrane when starting pains come on, it may be taken indeed as evidence, not merely that the cartilages are affected, but that the disease has further extended to the bone. When the disease, on the other hand, has commenced in the bone and involved the cartilages, the joint may speedily become opened; and the suppuration and abscess which occur there are attended with the symptoms which have already been pointed out. The treatment, as well as the diagnosis of diseases of articular cartilage, so far as they can be ascertained, will be found in the description of the affections of the other structures of the joints.

DISEASES OF OTHER TISSUES IN AND AROUND THE JOINTS.

We have seen that the diseases of the joints, which I have attempted to describe, are prone to affect in their progress the soft structures in the neighbourhood. The ligaments become relaxed and weakened; the muscles contracted; the areolar tissue forms the seat of abscess, or is traversed by sinuses; and the skin itself may be ulcerated or destroyed. The morbid action, on the other hand, may *originate* in the peri-articular structures, and either simulate disease of the joint or lead directly to it. The variety of these lesions is so great that it is impossible, within the limits of this essay, to attempt a detailed examination of them, and this indeed would be unnecessary, as their description will be found in other parts of the work. A few remarks, however, upon the relation of each of these structures to the pathology or diagnosis of joint-disease may not, perhaps, be considered out of place.

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* Lectures on Surgery, *Lancet*, 1829-30.

Diseases affecting the Ligamentous Structures.

The ligaments and fibrous structures around the joints are no doubt liable to inflammation, acute or chronic, in consequence of the injuries which they sustain from sprains or other accidents (see the essays on injuries of the different regions). It is probable, however, that the ligamentous tissues are by no means prone to disease; for they are often found unaltered when the other articular structures have suffered to a great extent. Slow to inflame, the reparative process appears to be slow also; for it frequently happens that the movements of a joint are hampered, and its use attended with great pain for a long time, after a comparatively slight injury, in which the ligamentous or tendinous tissues alone have apparently been injured. Opportunities of examining the parts in these chronic cases have not often been afforded, or have not, at least, been often made use of; but occasionally the ligaments have been found thickened and pulpy, independent of any actual laceration of their substance.

In the sketch of the advanced stages of articular disease we have seen the ligaments ulcerating or yielding, and so permitting the exit of matter from the interior of the synovial membrane, or allowing complete or partial luxations to occur. Sometimes, on the contrary, we find layers of a fibrous tissue, having somewhat of a lardaceous appearance and occasionally attaining a very considerable thickness, developed in the ligaments or in the areolar tissue around them, and forming the immediate cause of what is termed extra-capsular false ankylosis. In rheumatic and syphilitic affections, it is probable that the ligamentous structures share in, or even originate, the diseased action, and at least contribute to the pain which is so severely felt. In gout they may form the seat in which the urate of soda is deposited. In chronic rheumatic arthritis they suffer to a great extent; the capsular ligaments may be greatly increased in thickness, or portions of bone may be developed in their substance; and in the hip the round ligament may entirely disappear, or in the shoulder no trace of the glenoid ligament be left.

The ligaments, it was said, are liable to become relaxed in the progress of articular disease; a similar looseness of them is sometimes found as a primary affection, or at least dependent only upon some constitutional condition. In persons of lax fibres, especially in delicate or hysterical young women, a preternatural mobility of the joints is not uncommon, so that extension of the fingers or thumb may be carried nearly as far as flexion, and the nails and the back of the hands be made to meet. In many cases this state is not attended with any practical inconvenience; and even where partial luxations occur, the bones return at once to their normal position. Occasionally, however, it happens, perhaps in those persons in whom the undue mobility of the joints is not attended with a corresponding relaxed condition of the muscles, that complete dislocation takes place, which may not be reduced spontaneously, but require surgical assistance. Instances of this kind, involving an unusual liability to luxation, are frequently recorded. A similar condition of relaxation of the ligaments, involving loss of power of the articulation, and leading occasionally to luxation, may follow palsy of a limb, and is often met with as a result of infantile paralysis. In many children it is necessary to have recourse to mechanical contrivances to obviate this weakness, whilst means are being adopted to increase the muscular power by which the joint may be moved or the limb exercised. The symptoms, progress, and treatment of articular disease, as it implicates the ligaments, will be found included in the preceding sections.

Diseases affecting the Muscles.

The altered conditions of the muscles and their tendons, by which the joints are forced into certain positions, or retained in the positions they have assumed, may be primary or secondary in their relation to the articulation. In the latter case disease commences in the joint, and the muscles are affected subsequently, contracting spasmodically, or becoming fixed and rigid, so as to impede functional exercise of the joint even when the original articular affection is subdued. The muscular lesion, on the other hand, may be primary, as far at least as the joint is concerned; from some disturbance in the nervous system, an undue or unbalanced contraction of certain muscles occurs, and the articulation is fixed in a particular position, which becomes permanent if the muscular structure degenerates and loses its proper contractile material. Such a condition of spastic rigidity is sometimes found in the adult, the result usually of serious disease affecting the cerebro-spinal axis. It is much more common in early life, as a consequence of the infantile paralysis which, if seldom fatal, is frequently quite incurable. In many of these cases the amount of deformity which occurs is deplorable, and the malposition of the joint, so long as it lasts, obviates any hope of stimulating muscles to contract, or prevents that exercise of the limb on which any prospect of improvement depends.

Rigidity of the muscles, terminating, perhaps, in atrophy or degeneration, is often seen when a limb has been maintained for too long a time in one position, and especially when pressure has also been exercised on the muscles and their tendons, and their action arrested by the application of tight bandages. This condition of the muscles may also be accompanied by grave mischief within the joint. After fractures requiring prolonged immobility of the limb, or at least in which the limb has been kept fixed for a length of time, rigidity of the parts takes place to a greater or less extent, and is very obstinate in its duration. In some of these cases, and especially when the patient is advanced in life, or the constitution is otherwise predisposed to such alterations, we may find, as M. Tessier has pointed out, effusion of serum, mixed perhaps with blood, into the joint, the synovial membrane at the same time being injected and its vascular fringes swollen. In other cases the mischief may have advanced still farther, and the articular cartilages have materially suffered, becoming reddened from contact with the effused blood, and softened in their structure, or presenting actual loss of substance on their surface. These changes, it may be remarked, are not confined to the articulation in the immediate neighbourhood of the fracture, but extend to others which have been maintained in a similar state of fixedness. The importance of due action of the muscles need scarcely, therefore, be insisted on, or the propriety of having recourse to passive motion at the earliest period of which the case will admit.

Finally, it may be noticed that an articulation is sometimes found to be perfectly rigid, from muscular contraction, in that condition of the nervous system which we term hysterical (see Articular Neuralgia). By examining the limb, however, during natural sleep, or in the insensibility produced by chloroform, the relaxed condition into which the muscles fall, and the free movements which can be impressed upon the joint, leave no doubt as to the true nature of the case.

The subject of undue or impaired muscular contraction, and its results, will be found treated of in the essay on ORTHOPÆDIC SURGERY; but it plays so important a part in articular disease, that it was impossible to avoid all notice of it in this place.

Diseases affecting the Areolar and Adipose Tissues.

The areolar tissue around the articular extremities of the bones, or over the synovial membranes, commonly participates in the diseases of these structures, and is either simply œdematous, or, in severe cases, becomes the seat of abscess or permeated by sinuses. Acute inflammation, on the other hand, not unfrequently attacks the areolar tissue in the neighbourhood of joints, as the result of blows or contusions, of wounds, or of erysipelas. It occurs, too, in many cases as a secondary consequence of inflammation of the synovial bursæ. The inflammatory action frequently runs high, and there is much constitutional as well as local disturbance. The swelling is considerable, the part is hot and tender, the skin reddened, and any movement of the part, including the articulation, is attended with pain. There is usually much tendency to suppurate, and when the synovial bursæ are implicated, matter forms rapidly and in considerable quantity, presenting some resemblance to acute abscess of the articular cavity. The diagnosis, however, between this affection and disease originating within the joint, is not difficult. The rapidity with which the symptoms have come on distinguish it from disease of the bones; whilst the position of the swelling, which extends over and conceals the osseous prominences, prevents it from being confounded with synovitis. By careful manipulation, too, it will be found that the joint itself may be handled without producing pain, provided that no pressure or tension is exercised upon the inflamed parts around. This kind of inflammation is not uncommon in delicate or strumous children, in whom it is very apt to involve the articulation, unless great care is taken. The knee and the shoulder are the two situations, perhaps, in which the affection is most frequently seen.

The treatment in these cases is sufficiently obvious. The limb must be kept at perfect rest; poultices and fomentations applied; and if matter forms, early and free incisions should be made for the purpose of evacuating it, lest the pus should find its way into the synovial cavity, and the case become one of serious consequence, resolving itself, in fact, into acute suppuration of a joint. The incisions, though free, should not, of course, be so deep as to open the articulation, under the mistaken idea that this is already implicated. In strumous children the general health has to be sedulously attended to, and care taken not to depress the constitutional powers.

With respect to the affections of the adipose tissue, there is little to be said; according to Rokitansky, a branching growth of fatty tissue is occasionally met with, chiefly in the knee-joint, in the free part or in the duplicatures of the synovial membrane, corresponding to the lipoma arborescens of J. Müller.

Diseases of the Synovial Bursæ.

A description of the pathological affections to which the synovial bursæ are liable will be found in the essay on Affections of the Muscular System, to which the reader is referred. The situation of the subcutaneous bursæ, at least of those which are most liable to disease, is well known, and they are at once so accessible to examination, and the symptoms attendant on their morbid conditions so characteristic, that mistakes concerning them are hardly likely to arise. In the case of the deep-seated bursæ, however, this is by no means so certain. Their diseases simulate to a much greater extent disease of the joints in their neighbourhood, and, indeed, frequently lead directly to it; for in many instances these bursæ are continuous, or have some connexion with the articular synovial membranes, so that direct extension of inflammation may occur from one to the other. In the description, therefore, of the special characters which attach to the diseases of the individual joints, I shall have occasion again to refer to the deep-seated bursæ, and to the means of distinguishing their affections from those of the articulations.

Altered Conditions of the Integuments around the Joints.

The diarthrodial joints are intended to allow of free movements of the bones which enter into their composition. If these movements are interfered with, the joint is truly affected, whether the seat of the obstruction is in one of the proper articular structures, or has only an indirect connexion with them. Whenever the integuments have been extensively destroyed around a joint, the resulting cicatrix, and the accompanying induration of the subcutaneous areolar tissue, may cause the articulation to be partially or almost wholly rigid. The cases in which this usually occurs are those resulting from extensive burns; and here too we often find a limb rendered useless, and hideous deformity produced, by the original extent of the injury, or by the want of proper forethought during the healing process. In the essays on Burns and on Plastic Surgery, the importance of considering the position to be chosen for the limb, when the burn has invaded the circumference of an articulation, has been pointed out, as well as the best means to be adopted for preventing injurious contraction at the time, or for remedying it if it has unfortunately occurred. I have thought it right, however, not entirely to omit in this essay any allusion to the fact that a natural condition of the surrounding integuments is of importance to the integrity of the joint.

Ankylosis.

A want of precision occasionally attaches to the sense in which the term ankylosis is used. Originally, as the word itself implies, it was applied solely to joints which had become fixed in an *angular* or bent position; rigidity when the limb was straight receiving another designation (ὀρθόκωλον). The position which the limb has assumed is no longer specially designated, but we speak at the present day, somewhat clumsily it is true, of ankylosis as being *true* or *false;* the latter, at any rate, having a somewhat vague signification in the minds of many authors. By *true ankylosis* (*synostosis*) is meant actual osseous union of the contiguous bones. This implies, in most cases, destruction of the entire joint, and constitutes a further or final stage of the process of junction by fibrous tissue, which has been described in previous sections, and which forms one variety of false ankylosis. A form of osseous ankylosis, moreover, is sometimes met with in which the new bone is placed *outside* the articulation. This variety is most common in the spine, which occasionally presents superficial bridge-like bony processes extending from one vertebra to another, or even forming a kind of osseous sheath enclosing several vertebræ.

False ankylosis may be *intra-capsular*, when it signifies a junction of the articular surfaces of the contiguous bones by a comparatively soft or membranous tissue (the joint-cavity being partially or completely destroyed), or it may be *extra-capsular*, the union of the bones in this case depending on adhesions around the articulation, with thickening and induration of the capsular or ligamentous tissues in that situation. The latter, or extra-capsular false ankylosis, usually accompanies the former; but it may exist alone, as was seen in a case related by M. Bonnet, where the articulation was completely fixed even when section of all the muscles around had been performed after death, whilst the interior of the joint was found to be perfectly healthy, the ankylosis resulting from the presence of an enormous mass of fibrous tissue in the ham uniting the femur to the tibia.* Impaired mobility of the joints may result, no doubt, from other causes. In chronic rheumatic arthritis, for instance, the shape of the articular surfaces is altered, or bony vegetations are formed around them, which mechanically impede or arrest motion. The joint may be crippled by the contraction of cicatrices after injuries or diseases affecting the integuments and contiguous tissues. Muscular retraction, too (so often present in and complicating ankylosis), may alone interfere with freedom of movement. These cases, however, may be termed "articular rigidity," rather than ankylosis.

Ankylosis is occasionally seen in advanced life affecting some of the minor joints without the existence of much obvious cause to account for its presence. As a rule, however, ankylosis, whether true or false, results from inflammation, common or specific, which has affected a joint, and produced a certain amount of destruction of the parts, followed subsequently by reparative action. In the majority of joints there is little difficulty in determining the fact, that motion is at least impaired, if not altogether lost. In the hip and shoulder, however, it is necessary to be careful that increased mobility of the pelvis (especially noticed in children) or of the scapula is not mistaken for action of the articulation. The determination of the exact cause of the rigidity is not always easy. In chronic rheumatic arthritis, irregular osseous processes may, perhaps, be felt, and the character of the deformity will assist in the diagnosis. When retraction of the muscles is the sole or principal cause of the impaired mobility, the tendons may be felt rigid beneath the skin. If the areolar tissue around the entire joint or at one part of it is indurated, inextensible, and traversed by sinuses, we may suspect that the extra-capsular form of false ankylosis is not entirely absent. If some degree of motion, however slight, can be given to the joint, we *know* that true or osseous ankylosis is not present; although the converse of this is not equally certain, for in false ankylosis the firmness of union may be so great as to render it difficult to detect any motion, even when muscular opposition is removed by means of chloroform.

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* Bonnet *sur les Maladies des Articulations*, tom. i. p. 130.

Treatment. It has been already explained that a time may come in the progress of articular disease when it is necessary to exercise the joint; when passive motion must be had recourse to, and friction in its varied forms assiduously employed. These measures constitute what may be termed the preventive treatment of ankylosis. Supposing that they have not been adopted, or have been used too late, and ankylosis has actually taken place, the treatment will depend greatly on the position in which the limb has become, or is becoming, rigid. If the position is suitable in true ankylosis (synostosis), so slight an amount of further improvement can be hoped for, that no interference will probably be attempted. In false or fibrous ankylosis, on the other hand, if the case is seen at a sufficiently early period, the general plan of what was termed preventive treatment may usually be employed with safety to prevent soft union from becoming osseous, and also to increase such mobility as may be present, by stretching the soft uniting structures, and so adding to the usefulness of the limb.

The joint may have become ankylosed in the original sense of the word, or at least in a *faulty* position, for the same position is not of equal use in all articulations, or even in all classes of persons; in certain trades, for instance, a special position is often desirable. Early treatment, then, is necessary, if the limb is to be rendered serviceable instead of becoming simply an incumbrance. Supposing the case to be one of false ankylosis, the first thing to be done is, to place the limb in that position in which it may be employed to the greatest advantage, and subsequently, when inflammation has subsided, to increase the mobility of the joint, if any increase is considered possible. The means at our disposal for the purpose of relieving the deformity have been augmented by modern discoveries: by the employment of chloroform we annihilate pain, and get rid of the active muscular contraction which would greatly impede our efforts; and by means of subcutaneous Surgery we are furnished with a safe and ready method of overcoming the passive or permanently rigid state into which some of the muscles are likely to have fallen; a state which adds materially to the resistance offered by the joint.

The replacement may be immediate or gradual. In most cases, where the required amount of alteration is considerable, the immediate process is preferable, the dread of mischief arising in consequence of the sudden change from a position which may have lasted for a length of time, not being justified if the operation is properly performed. Indeed, it is remarkable how much forcible manipulation may be safely applied to a rigid and distorted articulation, even when inflammation is still in progress. In many instances, however, the restoration of shape can be effected gradually or painlessly by simple mechanical contrivances carefully adapted to the individual joint, and in such cases this plan of treatment may properly be adopted. (See the essay on ORTHOPÆDIC SURGERY.) If immediate reduction is determined on, it is desirable that the Surgeon should have a clear notion of what he is about to do; that he should have determined the position to be chosen, and calculated the obstacles to be overcome. The key to success in the process of immediate replacement consists in the previous manipulation. When the patient is placed under chloroform, therefore, the movements for the purpose of breaking down the adhesions which have formed should be properly adapted to fulfil their purpose. Instead of applying the force employed simply in one direction, by attempting *at once* to straighten the limb, the first process is to move the joint in every sense so as to render it as supple as possible. Accordingly the limb is to be alternately flexed and extended (or, it may be, abducted and adducted likewise) steadily and gradually with somewhat increasing force, till as much as possible of the natural extent of motion is obtained. Some minutes may elapse during this manipulation before the joint appears to yield; at length, perhaps, a cracking noise is heard, which becomes more and more evident as the movements are continued, and at the end, it may be, of half an hour the adhesions may have so far given way as to allow of motion in all directions to a very considerable extent, in a joint which had appeared completely ankylosed. When the adhesions are sufficiently broken down, the limb may then be placed, by appropriate traction and pressure, in a proper position, and secured on a splint.

Many cases of ankylosis, it was stated, are complicated by the existence of muscular retraction, which prevents the necessary movements for the relief of the ankylosis. If the existence of this retraction is evident, the muscles may be divided subcutaneously a few days before the main operation. It may happen, however, that a retracted condition of one or more muscles only becomes evident during the manipulation under chloroform. One of two courses may then be adopted. Having restored as much motion as possible to the joint, tenotomy may be practised on the opposing muscles, and the remainder of the operation suspended till the wounds have entirely healed. Or, as M. Bonnet recommends, after subcutaneous section has been practised, the movements may be persevered in till restoration of the articular functions is effected to the greatest practicable extent. If the latter plan is adopted, a very long but fine tenotomy-knife should be employed, and the integuments punctured at a considerable distance from the point of section of the muscle, to avoid if possible the risk attendant on the admission of air to the cut surface during the movements which are being performed.

As the effects of chloroform pass off, the pain which is experienced may be expected to be severe for some hours, but speedily subsides, without the development, usually, of any very severe inflammatory symptoms. Constant irrigation of the joint may be practised for the first day or two in the manner described in a preceding section, the limb being secured on an open splint (the plan I usually adopted at the Hospital for Sick Children); or the whole limb may be wrapped in cotton wool, and the bandage at once starched, as recommended by Bonnet. When the proper direction has been restored to the ankylosed limb, and any inflammatory symptoms produced by the force employed have subsided, it is time, if the case is one which allows of any hope of success, to adopt such measures as may tend to develop renewed mobility of the joints. For this purpose, baths and friction may be employed, and steady and judicious passive motion had recourse to, which may be performed by the hand (usually sufficient in the child); or still better, in the adult, by various mechanical contrivances, which could hardly be understood from any verbal description.

In estimating the chances of success from these proceedings, the age of the patient and the duration of the lesion are mainly to be considered. In youth, and especially in childhood, at an age, that is, under sixteen, the results are usually most favourable. In middle life, there is still a fair hope of success, or at least of much improvement. Beyond this period, however, and as advanced age is attained, the chances are much diminished; and if the lesion is of old standing, if the adhesions have acquired great solidity, or if the ankylosis is complicated with other local mischief, not much hope of benefit can fairly be entertained.

When the ankylosis is *osseous*, the means already spoken of are obviously inapplicable. Supposing the position in which the ankylosis has occurred to be inconvenient, it has been proposed by Mr. Barton of Philadelphia to remove a wedge-shaped portion of bone from the projecting surface of the angle formed by the limb; the extent of the broad part of the wedge varying, of course, with the amount of the deformity. When this osseous wedge has been removed, either from the ankylosed part itself, or a little above or below this point, as may be considered expedient, the remaining thickness of the bone is fractured, and the two surfaces brought together so as to redress the angular deformity previously existing.

Finally, cases of ankylosis are sometimes met with in which the limb is not merely useless, but an incumbrance, whilst the continuance of disease in the bones, or the existence of other complications affecting the surrounding structures, prevents replacement from being effected. It may then become expedient to remove the diseased joint, or even the entire limb. The propriety of such operations must obviously depend upon the merits or peculiarities of each individual case.

ARTICULAR NEURALGIA.

We frequently meet with cases where pains are experienced in the joints without any appreciable material lesion to account for them. In many instances these are termed, and no doubt correctly, rheumatic or gouty pains, for these two conditions may have manifested themselves unquestionably in other articulations, or may ultimately appear in those which have been the seat of the erratic suffering. Occasionally pain gives a brief warning of mischief about to be developed, which it precedes only by a short time. In the pyæmic condition, for instance, a sharp pain may be felt in some joint, and though no other sign of diseased action is present, we are led to expect the formation of matter in this situation, and the progress of events commonly justifies our apprehensions.

The pain may have a local origin, independent of any disturbance in the joint in which it is experienced. The pressure of a tumour on some nervous trunk may give rise to suffering referred to its articular branches; and all Surgeons are familiar with the fact, that pain in the knee is one symptom of disease within the hip, and yet this sympathetic affection may so mask the original disease, that I have frequently had children with diseased hip brought to me, in whom blisters or other local remedies had been applied to the knee, under the idea that *it* was the seat of mischief.

Unquestionably, however, the majority of these cases are dependent on that abnormal condition of the nervous functions which is termed hysterical. The condition, indeed, is not absolutely confined to the female sex, as the original signification of the term would imply (ὑστέρα, womb), for it may occasionally be met with in males, though far less frequently than in the other sex. When this exalted or excited condition of the nervous system prevails, a local direction is often given to the perverted sensibility, by some accidental concentration of the "*attention*" on the part. The physiological effects of undue "attention" on organs are of great interest, and serve to explain many curious phenomena exhibited in certain disturbed conditions of the nerve-centres, which may be induced artificially, as in hypnotism, or arise from less obvious internal causes, as in hypochondriasis. I am unable in this essay to devote more space to this subject, but must confine myself to a simple notice of the effects which may be produced by involuntary or automatic "attention." A woman is brought into close relation with some one suffering from cancer of the breast; the attention is directed involuntarily to the corresponding organ in herself; the part becomes painful, swelling even occurs, and what is termed neuralgia of the breast is set up. A case is related of a gentleman who lost an intimate friend from cancer of the œsophagus: the sufferings which he witnessed made a strong impression upon his mind; he began himself to experience difficulty of swallowing, and ultimately died from the effects of spasmodic dysphagia.

In hysteria, when the attention has been fixed on an articulation from mental or from emotional causes, or in consequence of some slight injury, symptoms which might be supposed to indicate structural disease of the joint are apt to show themselves. There is great *pain;* pain out of proportion to the other symptoms, and frequently extending over a large surface, but often suspended if the attention is diverted, and completely absent during sleep, which may be prolonged and sound. The *tenderness* is also exaggerated, and usually greater in the integuments than in the deeper structures; it is little felt, too, on firm pressure on the articular surfaces effected from a distance. There is sometimes a slight amount of *swelling*, which is diffused in the external areolar tissue, and arises from a turgid condition of the small vessels, or from increased effusion into the areolar interspaces. On handling the part, *fine crepitation* is often felt, evidently situated near the surface, and differing essentially from the grating or crackling which may be attendant on removal of the cartilages. Frequently *convulsive* or *spasmodic action of the muscles* is induced by any attempt to bend or straighten the joint; or sometimes there is a more permanent *rigidity*, by which the limb is fixed in some improper position. When volition is suspended, however, the rigidity and the spasm are suspended likewise.

General symptoms indicating hysteria are often present; in many cases there is habitual coldness of the extremities, with other evidence of weak circulation; but articular neuralgia is sometimes seen in stout and florid girls. Some irregularity of the menstrual functions is usually present.

The diagnosis in these cases is generally not difficult, for it is commonly easy to detect symptoms which unequivocally vary from those which would be induced by true structural disease. It may be mentioned, however, that in old cases the patient may have acquired so much information regarding the symptoms which ought to be present, that less chance is afforded to the Surgeon of detecting any palpable inconsistency. Where any doubt exists as to the true character of the affection, time should be taken before a positive opinion is pronounced; a careful examination, too, should be made, to detect and remove any local cause of nervous irritation; for these sympathetic pains may be maintained by disturbance of parts with which there is no direct nervous communication, and relief of the one will be followed by cessation of the other.

The general principles of the treatment have been laid down in the essay on HYSTERIA. In most cases tonics and antispasmodics are beneficial. Great attention should be paid to the due action of the skin and liver; and where a tendency to periodicity is present, quinine is of marked service. Change of air and occupation are beneficial, especially residence at the sea-side, where salt-water bathing, general or local, can be easily enjoyed. The patient should be urged and encouraged to use the articulation. If the limb is contracted, and any attempt at restoring the joint to its natural position is strongly resisted, chloroform may be had recourse to, and the part maintained afterwards for a *short* time on a splint, with advantage; but exercise of the joint should speedily be enforced. The moral treatment to be adopted is of material importance. The attention must especially be directed elsewhere, and healthy occupation given, if possible, to the mental as well as to the bodily functions. A judicious mixture of firmness with kindness must also be exhibited both by friends and Surgeon, and the confidence of the patient acquired, which can never be done if any form of deception is had recourse to, as has sometimes been recommended.

Injuries of the Joints.

Wounds of Joints.

The joints are liable to various and severe injuries. The ligaments and other soft parts in the neighbourhood may be strained or otherwise damaged; the bones may be suddenly forced apart, and their natural relation to each other altered; or a fracture may extend into and implicate an articulation. These injuries, however, have already been described, generally, under the heads of Dislocation and Fracture, or, as they affect the individual joints, in the essays which treat of injuries in the different regions. The subject of *wounds of the articulations* is the only one that remains, therefore, to be noticed in this place.

In treating of wounds of the joints, I shall confine myself to those which actually penetrate the synovial membrane. The wounds may be punctured, incised, or contused. The gravity of a *punctured* wound is influenced to a certain extent by the course which it takes, as well as by the nature of the instrument with which it is inflicted. When oblique in its direction, of narrow dimensions, and made with a sharp clean weapon, it corresponds to the wounds produced in subcutaneous Surgery, and has comparatively little tendency to give rise to suppuration; a direct wound, on the other hand, even of the same size, is more prone to produce serious mischief, especially if it is made with a blunt or jagged instrument. To a certain extent, the same observations apply to *incised* wounds, but their greater dimensions much increase the chance of the admission of air, and of the supervention of destructive inflammation, whatever the direction they have taken. *Contused* wounds of a joint may be inflicted from within, or from without. The former have been described under the head of Compound Dislocation; the latter are produced by heavy or blunt instruments, and are formidable from the injury of the soft parts they involve, and the consequent chance of mortification, as well as from the inflammation they may be expected to induce.

Under favourable circumstances, the edges of an incised or punctured wound, if maintained in perfect apposition, may unite speedily by the processes described in the essay on Wounds, and the articulation be restored to a sound and healthy condition. When the wound is much contused, the edges gaping, or when other circumstances are not favourable, severe inflammation takes place, suppuration rapidly ensues, and destruction of the joint may be expected to occur. The mischief may not even be confined to the articulation; pyæmia may be established; or the patient may sink, exhausted by the profuse discharge, and the fever excited by the local irritation; there is also a risk of tetanus making its appearance.

The causes of the grave character of these lesions are not, perhaps, difficult of comprehension. When early union does not take place, and repair has to be effected by what is called the "second intention," suppuration occurs; but the matter is formed not merely at the divided surfaces, as in ordinary wounds, but extends to, and accumulates in, a large and often intricate synovial cavity, which does not communicate freely with the surface, but allows of burrowing and confinement of the pus, and so favours its decomposition, with the consequent constitutional disturbances. The structure of some of the tissues which form the walls of the cavity is also most unfavourable when suppuration has occurred; instead of being vascular and full of life, soft and able to approximate and contract, the cartilaginous surfaces in the joints are unyielding, and so low in their vitality as to be little capable of efforts at reparative action; even when the cartilages disappear, the osseous structures which are exposed are themselves far less adapted for the process of granulation than the softer tissues, and obliteration of the pus-forming cavity becomes a slow and tedious process, often interrupted by local or constitutional mishaps. Finally, even if repair does take place, it has been effected at the expense of the functions of the part; for union of the opposing surfaces of an articulation involves ankylosis, and consequent loss of mobility,—the purpose for which the joint was constructed.

When a wound exists in the neighbourhood of an articulation, it may be of such a size, and have so freely exposed the interior of the joint, that no doubt can exist as to its extent. In certain cases, however, it is not always easy to determine whether the synovial membrane has been injured or has remained intact. We are guided in our opinion by the position of the wound, its direction, the degree of penetration, and the form of the weapon. Our diagnosis may be assisted by the flow of synovial fluid; but the absence of synovia does not prove that the articulation is uninjured (for its escape may be prevented by various circumstances), and its presence is not conclusive in favour of injury, for the fluid may have been discharged from a synovial bursa or from a tendinous sheath. When any doubt exists, the advice of the poet, "where ignorance is bliss, 'tis folly to be wise," may safely be taken; at any rate researches with a probe had better be avoided, and the case treated at first as if penetration had undoubtedly occurred.

The dangers attendant on a wound extending into an articulation are influenced by several circumstances. In early life such wounds are usually attended with less severity of symptoms than at a more advanced age, and a good constitution is more likely to do well than one which has been broken down by prolonged debauchery. A small joint will escape with impunity where a large one would be destroyed; and even if the articulation is destroyed, the general disturbance may be trifling. The upper extremity is more favourably situated than the lower, as far as the chance of recovery is concerned; and finally, a wound inflicted with a sharp instrument is more likely to unite than one which has been attended with much violence to the softer tissues.

In managing a wound of a joint, it becomes evidently of the highest importance to procure, if possible, immediate union, and prevent the occurrence or check the spread of inflammation. Every wound involves a tendency to inflammatory action; but the smaller the amount which is excited, and the more complete the absence of inflammatory exudation, the better the form of healing which occurs. The size of the wound, and the degree of violence with which it was inflicted, are elements in the production of inflammation over which we have no control; a third element is the duration or amount of exposure to the atmosphere; this is within our reach, and the importance which has long been attached to the prevention of access of air to a wounded joint is fully justified on theoretical as well as on practical grounds.

When there has been much laceration and contusion of the soft parts, little or no chance of immediate union exists. For the description of the management of this class of wounds, however, the reader may conveniently be referred to the essays which treat of Gun-shot Wounds and of Compound Dislocations; for contused wounds of joints usually fall within one or other of these two categories. In punctured or incised wounds, if seen at a sufficiently early period, the treatment is directed to procure rapid union, and prevent the occurrence of inflammation, or reduce it to a minimum. For this purpose, we retain the wounded surfaces in close apposition, and adopt such measures as will insure perfect immobility of the joint, whilst we exclude all exposure to the air. If any foreign or detached body is present,—a piece of glass, for instance,—it is carefully removed, and the wound, having been gently cleaned, must then be closed effectually, and its surfaces, for their entire depth, kept in close and steady apposition. The mode of effecting this must vary; where only a small puncture exists, it may be sufficient to apply a piece of lint, which may be soaked in blood or covered with collodion; if the wound is of some extent, something more is required; on the whole, sutures are preferable to adhesive plasters, being less liable to be disturbed, and admitting of the application of moisture to the part; the twisted suture appears to be the most efficient, as it maintains the divided surfaces in contact to a considerable depth. The limb must be carefully secured on a splint, or otherwise fixed in that position which will be most advantageous to the patient should rigidity ultimately occur. As perfect immobility is of the greatest importance, the splint must be carefully selected, so as effectually to prevent any articular movement. The immediate and continued application of cold to the part, in the form of irrigation or of iced water in vulcanised india-rubber bags, is usually attended with great advantage in preventing or subduing inflammation. The general treatment, at an early period, should be moderately antiphlogistic, without permanently lowering the strength, all of which may be required should events take an unfavourable direction. If active inflammation occur, it will be expedient to endeavour to arrest it at the very commencement by every means in our power; for inflammation in this case imports the most serious mischief. The treatment, therefore, both general and local, adapted for acute inflammation may now be promptly adopted, but used with discretion, and not persevered in unnecessarily when circumstances no longer call for it. Care should be taken not hastily to disturb the lint or the sutures, which may be left, indeed, with advantage for many days, perhaps a week, or so long as there is any hope of union being obtained, unless their removal is required to give exit to matter.

In spite of the measures adopted, or in consequence of the case coming too late under treatment, inflammation may run high and suppuration occur. When matter has unquestionably formed, any attempt at union is abandoned, and free exit afforded to the pus, either by enlarging the original wound, or, if necessary, by making free incisions in a more depending position. The further progress of the case does not differ materially from that already described under the head of Suppuration in Joints (see p. 712), to which the reader is consequently referred.

PART II.

DISEASES OF INDIVIDUAL JOINTS.

The limited space at my disposal requires that any observations I have to offer respecting the peculiarities presented by disease as it affects individual joints should be extremely brief.

Diseases of the Hip.

No other articulation presents such difficulties in respect to the diagnosis, and perhaps the treatment, of its lesions as the hip, owing to the depth at which it is situated, the mass of soft parts which surround it, and the little leverage afforded by its upper attachment in the pelvis. At the same time, unfortunately, disease of this joint is met with only too frequently, and constitutes one of the most troublesome lesions to which the human frame is liable.

As in other joints, the structures in which disease for the most part commences are the synovial membrane and the articular extremities of the bones. Some authors, indeed, have laid great stress on the amount of mischief which is sometimes found in the ligamentum teres at an early period of the disease, and have conceived that this structure is often the first to suffer; it may be, however, that the complete manner in which this ligament is surrounded by the synovial membrane, and the consequent intimate relation of the two, are concerned in the destructive effects of articular disease upon it, for internal ligaments might be expected to suffer earlier and to a greater extent than those which are placed external to the joint.

Common synovitis, as a primary affection, is less frequent in the hip than in the superficial joints; though when it occurs its symptoms are usually severe, and the suffering experienced considerable.

Strumous synovitis and ostitis. The disease of the hip which is most common, and which is so often met with in early life, is strumous inflammation, sometimes commencing in the synovial membrane, but frequently, also, in the articular extremities of the bones. As this disease often occurs at an age when it is difficult or impossible to obtain any definite information from the patient, we are frequently reduced to an observation of those symptoms which are visible to the eye. The special points in the symptoms which most attract attention are, the position which the limb assumes, the seat of the pain, and the localities in which abscesses may make their appearance.

After limping has existed for a variable time, and pain has evidently been felt on exercise, some alteration will usually be noticed in the position of the limb; for the femur scarcely ever preserves its proper direction in this form of hip-disease. The thigh is bent or flexed on the pelvis; that is, the axis of the thigh and that of the pelvis form with one another an angle opening forwards. Combined with this flexion, which is very seldom *simple*, are two principal deviations; in the one case we find inclination and rotation *outwards*, attended with apparent elongation of the limb; in the other, there are inclination and rotation *inwards*, producing apparent shortening. The causes of these apparent alterations in length are mechanical; supposing the femur to be bent at an angle on the pelvis, and the foot turned out, when the patient tries to stand or walk the weight of the limb has to be supported, but in order that the foot may reach the ground, that side of the pelvis is depressed and advanced in front of the other; in this way the limb *appears* to be elongated. In the opposite condition of flexion combined with adduction and rotation inwards, the corresponding side of the pelvis, for a similar reason, is raised and carried backwards; a position which involves apparent shortening when an attempt is made to place the limbs parallel with one another. The position which is recommended as best suited for examination is that in which the trunk and the *sound* limb are perfectly straight; the nature of the alteration, as it affects the diseased side, is then more evident than if the two thighs are placed parallel.

The fixed and altered direction of the affected extremity soon entails secondary deformity in other parts, especially in the spine. When the thigh is fixed at an angle with the pelvis, in order that the weight of the extremity may be supported, the pelvis itself becomes inclined forwards; to compensate for this inclination and maintain the balance of the body, the vertebral column is strongly curved, producing a deep hollow in the lumbar region, with corresponding projection of the abdomen anteriorly. The exact nature of this secondary deformity is readily seen, either in the recumbent or in the erect posture, on supporting the affected limb at the angle which it has assumed, when the pelvis and spine may easily be restored to their natural direction. Lateral deviation of the spine may also be induced, to compensate for the lateral inclination or twisting of the pelvis. The pelvis, it will be noticed, shifts or alters its position; and, indeed, increased mobility of the pelvic articulations often occurs to an extraordinary extent, especially in the later stages of hip-disease, when recovery is taking place, with ankylosis or rigidity of the hip itself. In such cases, in early life, the amount of motion which becomes developed at the sacro-iliac synchondrosis and other neighbouring joints may closely imitate the natural mobility of the hip, and easily deceive a careless observer.

The condition of apparent shortening frequently follows that of apparent lengthening, though it may occur where no lengthening has ever manifested itself. Is there ever any *real* alteration in length? Though many causes have been advanced which might give rise to actual elongation of the limb, it is hardly probable that any of these should actually occur, and it may be said that the lengthening is, in truth, only apparent, depending on the altered position of the pelvis. In most cases the same observation holds good with respect to the opposite condition. In exceptional cases, however, a certain amount of genuine shortening really does take place. When the osseous structures are involved in the disease, the spasmodic contraction of the muscles maintains constant pressure of the head of the femur on the upper part of the acetabulum; if this is already softened, and the cartilages ulcerated or absorbed, the border or edge of the acetabulum yields to the pressure, it becomes deeply ulcerated and excavated, and the head of the femur itself, which has been more or less disintegrated, is drawn up into this excavation, which is enlarged to receive it, in the direction of the external iliac fossa. This condition constitutes what has been termed *spontaneous dislocation* from scrofulous disease, which differs evidently from traumatic dislocation, in which the head of the femur clears the rim of the acetabulum, which remains intact. When this false or incomplete luxation has occurred, a certain amount of real diminution in the length of the limb will be present, increased, of course, if the head of the femur is destroyed to any extent. In very exceptional cases, too, the head of the femur is forced through the acetabulum, so as to enter the pelvic cavity. Accompanying these changes may be found a certain amount of alteration in the fulness of the nates. These are often flattened, and appear wider than natural. This alteration depends partly on wasting of the gluteal muscles from want of use, partly also, in the position of abduction, on the twist of the pelvis and consequent diminution in the projection of the tuber ischii.

The pain which is experienced, and which, as in strumous inflammation of other joints, is usually of slight amount in the earlier stages of the disease, is not confined to the hip, but is often referred to the inner side of the knee. The exact cause of this sympathetic pain, as it is termed, is not always clear. Any pressure in the region of the hip upon the trunks of those nerves which supply sensation to the knee, would be attended by pain in the latter situation, on the same grounds as we find pain often referred to the fingers or toes after amputation of the extremity. That pressure on the anterior crural nerve will produce pain at the knee, was shown by a case related by Sir B. Brodie, where pain in the knee, resembling that experienced in hip-joint disease, resulted from the pressure of a femoral aneurism on the anterior crural nerve, and subsided as soon as the aneurismal enlargement was relieved by ligature of the artery. We can easily understand that similar pressure on the obturator nerve would be followed by a like result. The pain in the knee has also been referred to a transference of impressions in the spinal cord, to sympathy between the extremities of the femur, or to propagation of the inflammation along the interior of the bone. From whatever cause it arises, this pain is sometimes the first symptom which attracts attention, and may lead to mistakes regarding the real seat of the disease. The chance of error is increased if puffiness over the knee accompanies the pain, as it does sometimes; just as swelling of the testicle may be produced by the passage of a calculus along the ureter, from pressure on the spermatic plexus, and consequent nervous disturbance of the nutritive conditions of the parts supplied by its peripheral branches.

When abscesses form, they may point in almost any part of the limb, either in the vicinity of the joint, or after having burrowed among the muscles to a great extent, especially when the erect posture has been long maintained. If the sinus is situated some distance down the thigh, near the inferior attachment of the tensor vaginæ femoris, the probabilities are in favour of the femur being the seat of mischief. When the acetabulum has originated or participated in the disease, and matter has formed in the pelvis, the abscess often shows itself at the outer part of the groin in the neighbourhood of the antero-inferior spine of the ilium; occasionally it passes down by the rectum, into which it may burst, or it may reach the surface close to the anus.

There are one or two points in the diagnosis to which I may briefly direct attention. I have seen congenital dislocation mistaken for hip-joint disease, and the child subjected to much unnecessary confinement and suffering. A little attention readily distinguishes the two affections. The history of the case, and the existence of evident limping from the first moment when any weight was allowed to rest on the limb, the absence of pain, and the extent of real shortening, aggravated when the limb is pressed upwards, diminished when extension is made, are symptoms of congenital dislocation which differ widely from those which would have been presented by severe disease of the joint. We occasionally meet with cases in which a difference in the length of the two lower limbs exists, resulting in some instances from congenital malformation, in others from infantile paralysis, which has led to wasting and defective growth of one extremity. Such a condition, if existing to any extent, causes limping in the act of walking, and leads to secondary deformity of the spine, in the form of lateral curvature, to counteract the tendency of the body to fall towards the affected side. This state might easily be mistaken for diseased hip, as well as for diseased spine, until a careful examination of the whole limb is instituted, when the cause of the symptoms is readily detected.

Psoas abscess, with or without disease of the spine, may be mistaken for hip-disease. The limb may be flexed on the pelvis, and any attempt at extension give rise to great suffering. It will be found, however, that, provided the psoas muscle is kept relaxed and no traction upon it be allowed, free movement of the joint may be effected, and its articular surfaces rotated on one another or pressed together with much force, but without suffering. The situation of the abscess serves to assist in the diagnosis; pelvic abscess, too, depending on hip-joint disease, is almost invariably complicated with sinuses in other situations. A case of this kind, where the psoas abscess was connected with extensive tubercular disease in and around the kidney, came under my care at the Hospital for Sick Children, which had been considered and treated previously as disease of the hip. Inflammation of the bursa under the psoas-iliac may simulate hip-disease, and be with difficulty distinguished from it. Sometimes, indeed, the bursa communicates with the joint, and disease beginning in the one involves the other in its course. If such is not the case, and the inflammation is confined to the bursa, there will be pain and tenderness on pressure at the front and inner part of the joint, with, it may be, some indistinct swelling in that situation; the mass of muscles, however, obscuring the bursal tumour. The limb is usually instinctively flexed on the pelvis, as in hip-disease, and any attempt to extend the limb, or any movement which involves traction on the psoas muscle, is attended with suffering. The diagnostic marks correspond to those just mentioned. If care is taken to avoid any pressure on the bursa, or action of the psoas, the joint may be freely handled without suffering; moreover, no tenderness or swelling can be detected behind the trochanter.

The treatment of strumous disease of the hip does not differ from that already recommended for strumous inflammation of the joints generally. The means of securing immobility of the articulation, however, may be briefly noticed. There is a certain amount of mechanical difficulty in keeping this joint at rest, which is not experienced in other articulations, for the reasons already alluded to. Short splints applied merely to the hip and thigh are of little service, for they do not entirely obviate motion; the only way of insuring perfect rest is by the use of the long splint, as in cases of fractured thigh; to this splint may be adapted iron-gauze at its upper part, moulded upon and encircling the pelvis, which it steadies more than any ordinary bandage. This splint not merely prevents motion, but may also be made to effect a certain amount of traction upon the muscles, and so diminish the spasmodic pressure of the articular surfaces on one another. For this purpose elastic bands may be adapted, if necessary, to the splint, as before described.

When suppuration has occurred, it is better that the matter should not be allowed to burrow deeply among the muscles. Dr. Bauer recommends an opening in the capsular ligament when "a considerable quantity of effused material" is contained within it; this may be effected with a pointed tenotomy-knife or a trocar inserted behind the joint at the spot where fluctuation is most manifest, usually about an inch behind and above the great trochanter. The capsular ligament is opened, and the limb inverted so as to force out the fluid. The wound is then to be carefully closed, and the limb replaced in its natural position, and secured on its splint. Where great pain exists, from the confinement of matter in the joint, this operation may in some cases justifiably be had recourse to.

If the case has gone on unfavourably, the bone become carious, and extensive suppuration taken place, resulting in sinuses, the health suffers, and the only chance of recovery, or even of preserving life, may consist in excision of the head of the femur, or removal of the diseased bone. Such an operation, in children at any rate, is more formidable in imagination than in reality, and I have had occasion to perform it without any injurious consequences. The subject of excision, however, will be treated of in a separate essay.

Morbus coxæ senilis. In advanced life another form of disease is apt to occur in the hip, which is known by the name of the *morbus coxæ senilis*, or *chronic rheumatic arthritis.* Unliko strumous inflammation, this disease seldom occurs under the age of forty, and often appears as a local affection, without any visible impairment of the general health. In chronic arthritis of the hip, there is stiffness of the articulation, and a certain amount of dull pain extending down the *front* of the thigh; the pain, however, though augmented after much exercise, diminishes during the night, and is not increased even by rough pressure of the articular surfaces against one another. The mobility of the joint is much interfered with, and a loud crackling can be distinctly heard when the limb is exercised. When the disease is well established, the foot is much everted, the nates are flattened, and there is *apparent* shortening of the extremity to a very considerable extent, in consequence of elevation of the corresponding side of the pelvis; a certain amount of *real* shortening may also take place after a time, from the changes which occur in the femur, the head of which may become altered in shape, and flattened, whilst the neck may assume a horizontal direction, so that the upper extremity of the bone may be placed below the level of the trochanter major. At this stage of the disease, too, bony protuberances may perhaps be felt around the articulation. The characters enumerated are so distinct from those of strumous disease of the hip, that mistakes between the two can scarcely arise. From sciatica it is distinguished by the character and situation of the pain, as well as by the presence of shortening of the limb, real or apparent, and eversion of the foot. The appearances presented somewhat resemble those of fracture of the neck of the femur, for which it might possibly be mistaken if any injury or accident had previously occurred. The history of the case, however, and the slow and gradual progress of the symptoms, as well as the osseous growths which are apt to form, are sufficient for accurate diagnosis. Where constitutional symptoms are present, the disease extends to other and smaller articulations, and the character of the affection cannot fail to be recognised. The treatment of this affection is noticed in the section on Chronic Rheumatic Arthritis.

Neuralgia of the hip. This joint is frequently the seat of hysterical pain, closely simulating structural disease. The diagnostic characters of this affection have already been pointed out (see Articular Neuralgia). It may be remarked, however, that apparent shortening of the limb may bo present in these cases, owing to alteration in the direction of the pelvis and its relation to the vertebral column, induced by long continuance in one unnatural posture. Lateral curvature of the spine also is frequently noticeable; but the nates are not flattened, and abscesses do not form.

Diseases of the Pubic and Sacro-iliac Joints.

The pubic and sacro-iliac articulations, in consequence of their anatomical arrangement, and the comparative unimportance of their synovial membranes (the place of which is supplied to a great extent by elastic tissue intervening between the opposed cartilaginous surfaces), are less exposed to disease than the proper diarthrodial joints of corresponding size.

As a consequence of hip-disease, especially in early life, the pelvic articulations become unusually movable; to such an extent indeed, that rigidity, or even complete ankylosis, of the diseased joint may be attended with but little loss of mobility of the limb. During pregnancy the union between the pelvic bones is said to become less firm, and in certain cases the relaxed condition of the sacro-iliac joint is so considerable as to give rise to pain, as well as to difficulty in standing or walking; during exercise, too, the patient may be sensible of a certain amount of motion between the sacral and iliac bones, and sometimes a distinct "crackling" can even be heard. In most of these cases the ligaments resume by degrees their normal condition, and the pain and limping gradually subside. Occasionally, however, the relaxed condition may last for a considerable period, and the limping may continue for months or years, or even, according to Ludovic, for the remainder of life. It may happen, too, that actual inflammation of the joint is set up; the pains become violent; there is swelling about the part; and if suppuration takes place, the case is most likely to terminate fatally.*

Acute inflammation of the sacro-iliac joint may result directly from injury. A case is related by Louis in which a sack of corn fell on the loins of a man who was stooping at the time. The accident gave rise to some swelling of the part, followed after a time by violent pain and much febrile disturbance, and death ensued at the end of the twentieth day. Very extensive inflammation, attended with suppuration, was found in the right sacro-iliac articulation, and the bones were separated to a certain extent from one another.

Disease of the sacro-iliac joint may arise from less obvious causes. Sir B. Brodie relates the case of a married lady who was unable to walk without crutches, and who experienced pain after taking exercise, referred to the right groin as well as to the right sacro-iliac articulation, where a projection existed, as if the ilium had been displaced and drawn upwards; the affected limb was two inches *shorter* than the sound one. Pains resembling sciatica had been complained of for many years, but the first distinct symptoms of the affection appeared to be referred to her pregnancy, four years previously. Recovery took place, though the limb remained permanently shortened.

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* See Desormeaux *sur les Relâchements, Ecartements, &c. des Symphyses du Bassin.*

Mr. Erichsen, who has paid much attention to the subject, considers chronic sacro-iliac disease to be usually strumous in its origin. It seldom, if ever, occurs, however, in children, being met with most frequently in young adults. The symptoms, according to Mr. Erichsen, consist of pain and swelling, confined to the region of the joint, and attended with a feeling of inability to support the weight of the body, and consequent limping when exercise is taken. The pain is increased by pressure, or by any motion of the affected joint; but if care is taken to keep the pelvis quite at rest, the hip may be moved freely in any direction. The foot is usually straight, but the limb is said to be apparently *elongated*, and the corresponding side of the pelvis is partially displaced, becoming twisted and rotated downwards and forwards. When suppuration takes place, and in most cases it only does so at a late period of the disease, the matter may point posteriorly in the immediate neighbourhood of the articulation, or it may extend outwards to the great trochanter, or upwards to the loin; if, on the other hand, the matter accumulates in front of the joint, it may pass into the perinæum or even open into the rectum, or it may leave the pelvis by the great sciatic notch and point in the gluteal region.

The prognosis in these cases is always unfavourable, but becomes specially so when matter has once begun to form.

Diseases of the Knee.

The diseases of the knee have been studied with extreme care, owing to the frequency of their occurrence, as well as to the size and accessible position of the articulation. Hence it is that the affections of this joint are often taken as typical of articular disease generally. The knee is liable to the various morbid changes which have been described in the first part of this essay; to one of them, indeed,—chronic inflammation of the articular extremities of the bones,—it is specially exposed, for *local abscess* is more common in the head of the tibia than in any other situation; and necrosis of the lower end of the femur is often met with, at first simulating, but subsequently inducing, suppuration of the joint.

The position which the limb habitually assumes in severe disease of this articulation, whether simply inflammatory or strumous in its origin, is one of considerable flexion, frequently combined with torsion, in consequence of eversion or inversion of the foot. If the ligaments become extended or destroyed in the progress of disease, the spasmodic contraction of the flexor muscles acts upon the head of the tibia, which it tends to dislocate backwards into the popliteal space. In our treatment, therefore, we have to guard against this tendency; the foot must be supported to prevent torsion, and where any risk of permanent rigidity exists the limb must be maintained in a nearly *straight* position.

In *chronic rheumatic arthritis*, the knee-joint soon acquires a strong inclination *inwards*, whilst the tibia is usually rotated outwards and the foot everted. At a more advanced period, if the limb becomes rigid in a semi-flexed position, the patella is occasionally found resting on the outer condyle of the femur, or even completely dislocated outwards. The amount of synovial effusion is considerable in the earlier stages of the disease, and the swelling will often be found to extend to the popliteal space in the direction of the inner head of the gastrocnemius, owing to distension of the bursa which exists in this situation, and which frequently communicates with the joint. As the disease advances, the patella becomes increased in breadth, and ossific deposits may be distinguished at the condyloid margins of the femur and on the head of the tibia. Pendulous excrescences, or completely detached bodies (loose cartilages), are frequently to be found in the interior of the articulation.

The *deformities of the knee*, and the treatment they require, are discussed in the essay on ORTHOPÆDIC SURGERY.

Inflammation or dropsical distension of various bursæ in the neighbourhood of the knee-joint may often be met with. Besides the superficial bursa over the patella, which gives rise in its diseased condition to "housemaid's knee," there is a deep-seated bursa between the ligamentum patellæ and the tibia, which may also be inflamed, producing pain on motion, with ill-defined enlargement in the region of the anterior tuberosity of the tibia. Occasionally that part of the synovial membrane which extends upwards beneath the extensor muscles is replaced by a bursa, which may be quite distinct from the knee-joint; or an imperfect division of the membrane into two cavities may exist. When a separate bursa is present, it may be inflamed and give rise to a painful swelling, which is confined, however, to the region above the patella, the articulation below remaining unaffected; this diagnostic mark is most evident when the patient is in the erect position. A swelling is often met with, especially in children, at the inner side of the popliteal space, connected with the bursa placed beneath the inner head of the gastrocnemius. As this latter bursa frequently communicates with the synovial membrane of the joint, inflammation of it is a matter of some importance, and care must be taken in our surgical treatment. Inflammation may also take place in the bursæ in connexion with the *patte d'oie* tendons at the inner side of the head of the tibia, leading occasionally to most obstinate and prolonged suppuration, and interfering with the movements of the joint, which does not, however, *directly* suffer.

It may be remarked, that in *wounds of the knee-joint*, when suppuration occurs, it often takes place insidiously in the areolar tissue, between the thigh-bone and the muscles which surround it, rather than in the articulation itself. In this way the whole thigh may be inflamed and swollen, and the appearances somewhat closely resemble those of acute periostitis of the femur. The depth at which the matter is situated prevents it from coming rapidly to the surface, and does not readily allow of fluctuation being detected. Much constitutional disturbance is, consequently, usually present, and the amount of pus which forms before an outlet is obtained is often very large. In such cases early and deep incisions are obviously called for; incisions which shall extend through the whole muscular layers, if the seat of the suppuration is to be reached, and the symptoms produced by the pent-up matter abated.

Diseases of the Ankle.

The ankle-joint is liable to the various diseases which have been already described, and is often involved in the progress of caries affecting the irregular bones of the tarsus. When distended with fluid, the tumefaction and fluctuation are most evident between the two malleoli, on either side of the extensor tendons; in extreme cases, the effusion is perceptible also posteriorly, at the inner and outer borders of the tendo Achillis. When suppuration occurs, the matter may make its way to the surface in the immediate vicinity of the joint, or it may ascend the leg, or descend into the foot in connexion with the tendinous sheaths around the ankle, so as to open at a considerable distance. The direction which the foot is prone to assume in disease interfering with the use of the joint is that of flexion, combined generally with varying amounts of inversion or eversion. The position to be selected, on the other hand, to avoid present stretching of the ligaments, and as most useful in the event of ankylosis, is that in which the foot is in the same plane with the leg, and forms with it an angle only slightly exceeding a right one. It may be remarked, that disease of this joint is more favourably situated for recovery than disease of the thigh or knee, because, by the employment of a wooden leg, whilst the ankle is carefully supported by splints, exercise may be taken, and the general health consequently maintained.

Chronic rheumatic arthritis seldom affects the ankle, but when it does, the tarsal joints are usually implicated at the same time. Increase in the breadth between the malleoli, which are preternaturally prominent, combined with projection inwards of the scaphoid and depression of the instep, are the appearances commonly noticed.

Diseases of the other Articulations of the Foot.

The tarsal bones are so small, and the articulations between them so numerous and in such close proximity, that distinctions between the morbid conditions of the two can with difficulty be drawn. Disease in the tarsus, in the majority of cases, arises in strumous inflammation of the bones, which soon extends to the cartilages and to the synovial membranes. Some importance must be attached to the original seat of the mischief, in consequence of the varying degrees of simplicity of the synovial membranes; of these, the median, or *scapho-cuneiform*, is by far the most complicated, as it extends between so many tarsal bones. When disease involves only the simpler synovial membranes, or is confined to single bones in connexion with them, the probabilities of a successful issue are comparatively great; and if operative measures are necessary, excision of individual bones may be had recourse to with satisfactory results. I have several times removed the calcaneum, the cuboid, or even the internal cuneiform, and recovery has occurred with a very useful foot. When disease affects the astragalus or the scaphoid, on the other hand, and the contiguous synovial membranes are implicated, the chances of localising the mischief become much diminished. The middle and external cuneiform bones, also, are unfavourably situated, though less so, perhaps, than the astragalus or scaphoid. It may be remarked, that the repair which takes place after excision in these cases is usually most complete, for a large portion of the periosteum is, and ought to be, left behind in the operation; reproduction of the bone consequently occurs to a greater or less extent, giving to the foot all the solidity which is required. After removal of the whole of the calcaneum, I have found the heel perfectly rigid, and the amount of deformity very trifling.*

Inflammation of the complicated *scapho-cuneiform* synovial membrane may be looked upon, according to Mr. Erichsen, as a distinct affection of the foot, commencing usually in disease of the scaphoid. At first there is pain and swelling in the region of the joint between the scaphoid and cuneiform bones. The pain is increased by bending down the foot, and extends across the tarsus to its outer side, as the articulation between the external cuneiform and the cuboid becomes involved. At a later period "the foot assumes a remarkable bulbous or clubbed appearance; the symmetry of the heel and the outline of the ankle are unimpaired, but the fore part and dorsum of the foot are greatly swollen, glazed, and possibly perforated by sinuses discharging their unhealthy pus."†

The diseases of the metatarsal and phalangeal articulations call for no special observations. They are frequently *gouty* in their character, or, in some cases, are examples of *chronic rheumatic arthritis.* It is worthy of notice, perhaps, that in the metatarso-phalangeal articulation of the great toe, the deformity induced by the latter affection has been mistaken for dislocation; a condition which it may closely resemble.

The subject of *bunion* is considered in the essay on AFFECTIONS OF THE MUSCULAR SYSTEM.

Diseases of the Sterno-clavicular and Acromio-clavicular Joints.

A certain amount of enlargement of the sterno-clavicular as well as of the acromio-clavicular articulations may sometimes be seen in persons who have long been in the habit of working hard with their upper extremities. Acute inflammation of the sterno-clavicular joint is also met with occasionally. Such a case in an adult came under my care, in which suppuration rapidly took place, with destruction of the fibro-cartilage, inducing spontaneous dislocation of the inner extremity of the clavicle. The shoulder and arm having been fixed, and the dislocation reduced and prevented from recurring by appropriate splints, recovery took place with a useful extremity.

Chronic rheumatic arthritis of these articulations may also occur, producing enlargement of the articular extremities of the clavicle, stiffness and pain on movement of the joints, as well as weakness of the upper extremity.

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* See also *Pathological Transactions*, vol. xi. p. 217, for an account of the condition of the parts in a foot from which I had removed two of the tarsal bones.

† Erichsen's *Science and Art of Surgery*, 3d ed. p. 715.

Diseases of the Shoulder.

The shoulder-joint resembles the hip in its anatomical characters, but is, fortunately, far less subject to disease, and when disease occurs the results are usually much less severe, the persistence of pain and the production of rigidity constituting the conditions most to be apprehended. If suppuration takes place, which is seldom the case, the matter often follows the course of the long tendon of the biceps, and opens at the front of the arm below the deltoid. Not unfrequently, too, it passes out of the articulation by the opening which exists in the synovial membrane beneath the subscapularis, and follows that muscle, arriving at the surface near the back and lower part of the shoulder. The most favourable position in which a diseased shoulder can be placed for treatment, is that which is almost naturally adopted; the arm should be parallel to the trunk, and the elbow slightly separated from the chest, the fore-arm being at the same time supported by appropriate mechanical means.

The condition of parts induced by *chronic rheumatic arthritis* of the shoulder has, no doubt, been frequently mistaken for the result of injury. After the stage of synovial distension has passed, wasting of the soft parts occurs; rigidity, as well as crepitation on movement, are met with, and the head of the humerus appears to be elevated and carried forwards. When the disease is of long standing, the deltoid is atrophied. The capsular ligament is usually thickened, and has sometimes osseous particles in its substance, or it may be perforated at its upper part. The synovial membrane shows marked signs of inflammation. The glenoid fossa loses its ligament as well as its cartilage, and presents the characteristic ivory-like material; occasionally, too, irregular osseous growths are found around its edges, increasing its capacity. The under surface of the acromion, and even of the acromial end of the clavicle, may be hollowed out by pressure of the humerus upon them, and are often covered with a polished porcelain-like material. Separation of the acromion is also met with sometimes. The head of the humerus is often much enlarged, and its surface eburnated. The tendinous structures around the joint may appear partially disintegrated, and the intra-articular part of the long head of the biceps is usually destroyed, the remains of the tendon adhering to the edges of the bicipital groove.

Disease of the *deep-seated bursæ* around the shoulder-joint is occasionally met with, and may prove somewhat perplexing. The bursæ beneath the *subscapularis* and the *infra-spinatus* habitually communicate with the synovial membrane, so that their diseases are in fact those of the articulation itself. The bursa beneath the *deltoid* is distinct; and when that bursa is inflamed, the muscle is rendered unusually convex, and any contraction of it is attended with pain. The articular surfaces, however, can be freely pressed together, and the joint exercised without suffering, provided the deltoid is not used, and no pressure is made on the tumour. A sensation of fine crepitation can often be felt in these cases on moving the shoulder.

Diseases of the Elbow-joint.

The diseases of the elbow resemble those of the knee, although they are less severe in their character, and more favourable in their results. This remark, indeed, applies, for obvious reasons, to all the articulations of the *upper* as compared with those of the *lower* extremities. When effusion takes place into the synovial membrane of the elbow, the swelling is most evident at the back of the arm, on each side of and above the olecranon; it is also perceptible at the outer side of the fore-arm, beneath the extensors. If suppuration occurs in the joint, the direction in which the matter can make its way with the greatest ease is upwards and backwards between the humerus and triceps; abscesses point, therefore, usually at the borders of this muscle, the outer being the border more commonly selected. The synovial capsule may also give way in front, in which case sinuses will be met with at the side of the brachialis anticus. If the bones are diseased, however, the fistulous orifices may lead directly to the part which has become necrosed or carious. In cases of *strumous ostitis*, which is somewhat common in this region, complete death and separation of a portion of bone in the olecranon, or in one of the condyles, frequently *with* but sometimes *without* the existence of caries, is by no means unusual. A comparatively slight operation, therefore, is occasionally successful in cases where excision of the articulation might at first sight have appeared necessary. The radius, it may be remarked, is less prone to suffer than either the humerus or the ulna.

The position in which the joint should be placed when splints are required, is that in which the fore-arm forms a right angle with the arm, and is in a state intermediate between pronation and supination. As the joint naturally falls into this position in consequence of its affording the patient the greatest amount of relief, secondary dislocation is rare, the only one which is met with being luxation of the head of the radius outwards and backwards, depending probably on the hand having been kept in a state of forced pronation.

Chronic rheumatic arthritis, when it attacks the elbow, is seldom confined to a single articulation, so that the nature of the affection is usually clear. Bony nodules and vegetations are of frequent occurrence in this disease, taking the form occasionally in the ulna of "additamentary bones." Detached or pendulous bodies are often met with, sometimes in great numbers.

Disease of the bursa over the olecranon, constituting "miner's elbow," can scarcely be confounded with disease of the joint. When inflammation attacks the bursa beneath the triceps, however, more care is necessary. According to Mr. Barwell, the condition here closely resembles that which is met with in the knee; a synovial bag existing between the triceps and the humerus, which may be a distinct bursa, or, as is more commonly the case, be a prolongation of the articular synovial membrane. Mr. Barwell remarks that, in inflammation of the bursa when it does *not* communicate with the joint, "there will be no swelling or puffiness between the inner condyle and olecranon process when the arm is bent at right angles; but the infallible test is, that the line of junction between the head of the radius and the humerus is as clear and well-defined as ever. If, on the other hand, the inflamed structure communicate with the joint, then these parts will participate in the general puffiness and swelling."*

Diseases of the Wrist, and other Articulations of the Hand.

The complicated relations of the various synovial membranes at the wrist and around the carpal bones facilitate extension of disease from one to the other; the anatomical arrangement explains also, to a certain extent, why it is that the bones are so frequently affected in articular disease of this region. The most favourable position in which the hand can be placed in disease of the wrist is one intermediate between flexion and extension, as well as between pronation and supination. This position is the one naturally adopted when the hand and arm are supported in a sling. In the recumbent posture, however, the hand usually lies on a cushion in a state of complete pronation; a condition which places the posterior ligaments on the stretch, and favours luxation backwards, the only form of spontaneous dislocation to be apprehended. In acute inflammation of the wrist, therefore, relief may often be afforded by so adapting the mechanical support as to obviate this tendency to pronation. If luxation of the ulna has already occurred, and the triangular fibro-cartilage been destroyed, the hand must be secured in the position recommended, and pressure exercised on the back of the ulna to reduce its dislocation, and maintain the bone in its normal position. As stiffness of the fingers is very apt to occur from want of exercise in cases of diseased wrist, passive motion of their articulations must be had recourse to as early as possible.

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* Barwell *on Diseases of the Joints*, p. 347.

Chronic rheumatic arthritis of the wrist is most common in females beyond the middle period of life, though it is met with occasionally at an early age in both sexes. The back of the wrist in this form of disease exhibits usually a peculiar projection in consequence of enlargement and partial luxation backwards of the ulna, and, though to a much less degree, of the radius. The fingers are frequently distorted, becoming permanently flexed as well as adducted; the *second* phalanges, however, of the fingers, as well as of the thumb, are usually *extended*, giving to the hand a peculiar appearance highly characteristic of the disease in its advanced stage. Enlargement of the articular extremities of the fingers is very common, representing the "nodosities" of Dr. Haygarth. Partial or complete luxations of them may also be present.

Synovial tumours, or "ganglia," about the wrist are treated of in the essay on AFFECTIONS OF THE MUSCULAR SYSTEM.

Diseases of the Temporo-maxillary Articulation.

The only affection of this joint to which it is necessary specially to direct attention is *chronic rheumatic arthritis.* This disease usually attacks the jaw in old persons, though it has been seen in early life; generally speaking, too, it is constitutional rather than local, and shows a marked disposition to symmetrical disturbance. The condyle and ramus of the lower jaw are usually enlarged and elongated; in a case related by Cruveilhier, however, the condyle was found to be entirely absent. The glenoid cavity is more or less altered, being frequently enlarged, and sometimes forming a plane surface. The articular cartilage and fibro-cartilage generally disappear, but the porcelain deposit is not common, and foreign bodies are rarely, if ever, present. The symptoms consist principally in stiffness of the jaw, and inability completely to open the mouth, with a crackling noise when the joint is used. The face is distorted; if only one articulation is affected, there will be some projection, and the face is turned towards the opposite side. When both articulations are diseased, the whole jaw is carried forwards. The symptoms, however, are commonly less urgent than those presented by the same disease in other joints,* so that its existence in this situation may scarcely be noticed when many parts of the body are affected.

ATHOL A. JOHNSON.

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* Dr. Humphry, however, refers to a case in which this disease caused so much discomfort and distortion of the face, that he was led to excise the condyle of the affected joint, and with very good result. Humphry *on the Human Skeleton*, p. 306.

ON EXCISION OF BONES AND JOINTS.

Excisions in general.

THE operations which are to be described in the sequel are all of modern introduction into practice; for although scattered passages are found in the writings of the medical authors of antiquity which have been held to prove that they were acquainted with the possibility of dissecting out diseased or injured bones, it must be allowed that such passages are in many respects dubious; and it is at any rate certain, that operations of this kind were very rare in olden times; that no rules were laid down for them in ancient Surgery; and that they had altogether passed out of notice before the revival of Surgery as an art founded on rational principles. When this had once happened, an attempt to preserve a limb by removing only the diseased portions of bone was so reasonable, that it was sure to be made; nor will it now be denied by any one, that a large amount of success has attended that attempt.*

I propose here, as well as my limits will permit, to treat, *first*, of the general indications for excision of entire bones or of their articular ends, as opposed to treatment without any operation, or to orthopædic measures, or to amputation; and, *secondly*, to describe the operations in use for removing certain entire bones, and the joints which are accessible to such treatment.

In considering the question between excision and what may be termed the expectant treatment, it may be laid down as a general rule, that a large or important joint ought not to be excised while any reasonable prospect exists of a cure without operation; but when bones which are of no great size, and removable by a moderate operation, are extensively diseased, the Surgeon may very reasonably propose to cut short the disease by excising the entire bone, while yet he may allow that cure is not hopeless should the patient's circumstances allow of his obtaining prolonged and judicious treatment; for the result of prolonged treatment is always doubtful, and the most fortunate termination which could be obtained by many months or perhaps years of care, will leave the patient's condition little better than the operation, from which he will, in all probability, recover in a few weeks (see p. 749). I have had very frequent opportunities of noting the success of operations for the removal of bones of the tarsus and metatarsus, and the superiority of such treatment to that of waiting for a cure—especially in children, whose restlessness renders confinement less likely to be borne. In the hand and wrist, however, such operations are far less applicable, on account of the difficulty of performing them without wounding some of the tendons, and so inducing loss of motion; while in the natural cure the tendons very commonly escape.

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* I have not space here to trace the history of excisions from the introduction of the operation by Park and the Moreaus; but would refer the reader for this, and many other points connected with the history and statistics of excision, to a very valuable essay recently published in the United States, *The Excision of Joints*, by Richard M. Hodges, M.D., Boston, 1861.

Connected with this part of the subject is the question of the total or partial extirpation of the bone. If the function of the diseased bone be not very important, it is always better to remove the whole of it, since it is often hardly possible in an operation to judge of the real condition of the bone; and if the entire thickness of the bone has to be taken away for any considerable extent, it is very doubtful whether the parts left behind will be of any use; while if the whole be removed, and no osseous tissue be left exposed in the wound, the latter will heal much more readily and with less danger of systemic infection.

But the question which far more often perplexes the Surgeon is not that between excision and the expectant treatment,* but between excision and amputation. This is so extensive a subject, and so much dependent on the circumstances of each individual case, that I can hardly hope to do more than indicate to the reader the leading considerations which apply to it. They are drawn from numerous circumstances, which may be thus grouped: 1. the situation and functions of the bone or joint to be excised; 2. the state of the patient as to general health, constitutional affection, and age; 3. the nature and extent of the disease; 4. various extraneous circumstances. I will proceed, as briefly as possible, to point out the most common indications for one operation or the other under each of these heads.

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* Except, perhaps, in cases of disease of the hip-joint. Reference to this subject will be found below, under the head of Excision of the Hip.

1. As to the situation and functions of the bone or joint affected. In the upper extremity, almost any excision which affords a prospect of preserving to the patient the motion of the elbow, of the hand, of the fingers, or perhaps even of the thumb only, is to be preferred to amputation, even although the patient may not recover useful motion in the joint operated on, whether it be the shoulder, or the elbow, or the wrist. There is, however, a limit to the application of this rule, since a limb which swings useless, like a flail, may prove more of an annoyance than an advantage. In the hip no question of amputation for disease ever occurs under ordinary circumstances, in any case where excision is possible: and in gunshot injuries, which are almost the only cases in which the operations are pitted against each other, the nearly uniform fatality of primary amputation at the hip, in modern military Surgery, gives the Surgeon a decided leaning to excision. In the knee the question is more difficult, and the advantages of the stiff limb, left after even the most successful excision, over the artificial substitute (especially in the case of a wealthy person, who can afford to purchase the ingenious artificial limbs now manufactured), are not so great as to balance, in the minds of some Surgeons, the increased danger to life which (as I fear we cannot help admitting) the operation entails, combined with the risk of failure and of the necessity for consecutive amputation. But there seems every reason for thinking that excision of the knee will soon be generally adopted in patients otherwise healthy, when the disease is only of limited extent, so as to be curable by the removal of thin slices of the affected bones. In injuries of the knee, excision has not as yet been much practised, nor has the experience obtained of it been very satisfactory; the injuries to the knee that demand operation in civil practice are generally too extensive for excision, and, as we shall see, other reasons usually preclude it in military Surgery; but in limited injuries it will occasionally be attempted in both civil and military practice. Below the knee, the excision of large portions of the bones of the leg seems much practised in Germany; but chiefly in necrosis, of which we shall have to speak presently. The excision of the ankle is an operation which I have not had an opportunity of performing or seeing. It appears to have occasionally yielded satisfactory results in the hands of Mr. Hancock;* but amputation at the ankle-joint is so much less severe an operation, and so much more sure of success, that few Surgeons

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* Barwell *on the Joints*, p. 463.

care to attempt excision. In cases of injury, the comminuted portions of bone may occasionally be removed, and a useful foot preserved; but no rules can be laid down on this point. In the tarsus, the removal of the os calcis when much diseased or extensively injured is a very successful operation, and one which should always be preferred to amputation. The astragalus, when dislocated, has been excised without much impairment to the usefulness of the foot; but I am not aware of any case in which this bone alone has been excised entire for disease, nor could the opportunity often occur. The bones of the front of the tarsus are far less favourably situated for excision, since they are all enveloped in the folds of a common synovial membrane, and therefore are prone to participate in each other's diseases; but still, in the cases, which are so common, of caries attacking the cuneiform or cuboid bones, an attempt ought always to be made to save the foot, by removing the bones affected, whenever the disease has not spread too far. When one or two metatarsal bones are extensively diseased, they should be dissected out, the toes being removed at the same time, if the operator thinks fit. I have only had occasion to practise this on the first metatarsal bone, which I have several times removed with very good results, leaving the great toe, which will derive so much support from the next toe as to become extremely useful.

2. With respect to the state of the patient, it may be said, in general terms, that excision of large joints is only to be recommended for patients in good health, not worn out by previous disease or confinement, nor deeply affected with constitutional taint (rickets, struma, rheumatism, or syphilis); nor should such an operation be practised on patients past the middle period of life. In the very early period also, many risks may be run with a view of preserving the limb entirely; and, after the failure of such attempts, the case has usually passed beyond the reach of excision, and amputation becomes necessary.

3. As to the disease—excision is never to be recommended for the removal of malignant diseases of the joint-ends or other parts of the bone. It is true that such operations have been practised by very good Surgeons;* but they must be regarded as experimental proceedings, justifiable in the early period of the operation, but contra-indicated by more extensive experience. Nor should excision be practised on account of acute abscess of the knee-joint, and only with much caution in acute diseases of any joint. It is

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* *Path. Soc. Trans.* vol. viii. p. 346.

much better to endeavour by free incisions and appropriate treatment to support the patient through this stage, with a view of removing the joint (if the extent of the disease renders it practicable) at a later period; but should the patient's health be giving way under the irritation of acute abscess, amputation is indicated in the knee and ankle, and the prospects of excision in other joints are very much less favourable than in chronic cases. The most appropriate cases for the excision of joints are those of chronic disease of all the tissues (white swelling), in which the bones are probably not affected to any great depth,—a disease due in most cases to a strumous taint, but in which the constitutional affection may have subsided or be no longer active. For excision of bones, necrosis of their shafts is the most favourable condition, since the periosteal sheath may be relied on to reproduce the bone to a sufficient extent to restore the functions of the member. In such conditions whole bones of the upper extremity have been removed, without any detriment to its ultimate usefulness. In extensive caries, on the other hand, amputation is clearly indicated in the lower extremity and wrist; while even in the shoulder and elbow, though an attempt to preserve the limb when the carious disease extends considerably beyond the epiphysal ends may not be unjustifiable, it must be allowed to be of very doubtful benefit.

4. The extraneous circumstances which may decide the Surgeon to perform amputation, in a case otherwise favourable for excision, refer principally to the lower extremity, and depend on the facilities for after treatment. Excisions in the lower limb require, in order to have a fair prospect of success, uninterrupted care and unbroken repose, in appropriate position, from the moment of the operation, for many weeks or even months. Hence the great rarity of the performance of excision of the knee in military practice, and the bad success which has attended it. Or the patient's irritable habits and impatience of confinement may occasionally lead to the preference of amputation.

General Observations on the Operations of Excision.

In the resection of any large joint, except the hip and the shoulder, it is of importance to remove the whole articulating surface. Partial excisions, though they appear to succeed well enough in the two great ball and socket joints, are repudiated in the case of the large ginglymoid joints by all Surgeons who have had experience of such operations; and even in the hip and shoulder many prefer total excision. Hence it is necessary, in the first place, to make free incisions externally, in order to be able to turn the ends of the bones out of the wound, and apply the saw above the articular surface. The removal of the diseased bone piecemeal, by scooping out the joint-ends, is a very inferior practice, since it is so difficult to judge of the condition of the part left behind, and the union is liable to be very irregular, and will probably be delayed by the separation of numerous small nodules broken away from the bone, but not removed. Whereas, if the end of the bone be well exposed, and a clean section made with the saw, the condition of the part left behind can be ascertained with almost entire certainty, and the parts are placed in the most favourable circumstances for union. In the upper extremity, where freedom of motion after the operation is sought for, it is desirable to prevent too extensive cicatrisation, and especially the adherence of the cicatrix to the bones. Therefore, when the operation is completed, the parts should be carefully readjusted; those parts of the wound in which it is wished to secure speedy union without puckering should be brought together with silver sutures, while free exit for the matter in other parts of the incision is allowed. It must not be forgotten that excisions are not, under ordinary circumstances, performed until the joint has become disintegrated by chronic disease, so that both the parts around the joint and the parts which form it vary very much from their natural condition. Around the joint, the thickening produced by old inflammation, and the burrowing of abscesses and sinuses, tend to obscure the natural relations and appearances of the parts; while in the joint, old dislocation and partial ankylosis may render what would otherwise be an easy operation inordinately difficult, and may even make it almost impossible to recognise the parts exposed. Then again, the contraction of the tendons, which sometimes accompanies long-continued disease of the joints, may have reached such a point that the limb cannot be placed in the proper position without the aid of tenotomy. In consequence of all these circumstances, the knife must be kept close to the bones when they are reached, in order to avoid any part which it may be desirable to spare, but which the morbid condition of the tissues prevents the operator from seeing; and the Surgeon must be prepared to vary his proceedings slightly with the varying condition of the articulating ends of the bones. As to the thickened synovial membrane, which so often lies around the diseased joint-ends, it is well, I think, to cut away as much of it as can be removed without trouble or risk; but I have not observed any harm from leaving small portions of it behind. Before the patient has recovered his consciousness, the limb should, in all cases, be carefully secured upon a splint, in the position it is intended to maintain for the first few days after the operation. This position need not necessarily be the one most favourable for ankylosis, except where bony union is desired. In that case the limb ought never to be moved, if it can be avoided, out of the position in which it is intended to ankylose; and the first dressing, or change of splint, after the operation ought to be delayed as long as due attention to cleanliness allows.

As to the instruments required in excisions, little need be said. These operations are no exception to the general rule, that difficulties are better overcome by the dexterous use of common instruments than by the invention of special and often complicated apparatus. The elaborate instruments described, usually in French surgical works, appear to be really intended to save the Surgeon from the necessity of thoroughly exposing the bones, by turning down proper flaps, and thus to enable him to remove the bones piecemeal; and if so, their principle is radically bad. The chain-saw, which seems to be much used in France, is hardly ever employed in England, though it may be useful occasionally in deep-seated parts. Some operators like to steady the bone, and guard the parts around, by passing under it a large director, mounted on a handle; and such an instrument may be very convenient when the bone cannot be turned out of the wound. The saw called by the name of its inventor, Mr. Butcher, will often be found useful. It is similar to the ordinary metacarpal saw, except that its blade is movable, and can be fixed at any angle, so that it can often be introduced and worked where an ordinary amputating saw cannot. The latter, however, is much better for sawing off a piece of cleanly-exposed bone; as Butcher's saw is rather liable to bend, and the blade is apt to get loose. The large bone forceps, with a double jaw, called by Mr. Fergusson "the lion-forceps," are almost indispensable for holding firmly the piece of bone which is to be sawn off. These instruments, together with cutting-pliers, a keyhole-saw, gouge, chisel, trephine, blunt bone-forceps, and curved spatulas, are all the special apparatus necessary.

The bones to be removed ought always to be taken away as clean as possible, and if, in removing entire bones or portions of their shafts, the periosteum can be left behind, it will no doubt be an advantage, as tending to give more firmness to the cicatrix; but in the excision of large articulations "subperiosteal resection" seems neither very practicable nor of any undoubted utility.

In necrosis, and occasionally in the most advanced stage of caries, the periosteum will be found so detached from the bone, that by keeping the edge of the knife carefully upon the latter, its investing membrane will be left behind, and with it (at least in cases of necrosis), in all probability, the germs of a considerable reproduction of the bone; but in cases of comminuted fracture, or in those most common cases of excision of joints, where the bones, though ulcerated on their articular surface, and somewhat softened throughout, retain their vitality, the operator could only hope by the expenditure of much time to succeed in leaving in the wound some scraps of lacerated periosteum, the use of which would hardly repay the trouble spent upon them.* The common-sense view of the case seems to be, that disease when very extensive has passed beyond the province of resection, unless the function of the whole bone can be dispensed with; except in necrosis, when it has arrived at the stage of sequestration, and separation of the periosteum, accompanied by the formation of new bone. In such a case the operation comes much nearer to the removal of a sequestrum than to excision properly so called. Under these circumstances, as much as fourteen inches of bone have been removed from the vicinity of the elbow, and a useful arm has been preserved. These operations for extensive necrosis are indeed triumphs of conservative Surgery, but have little bearing on the question of subperiosteal resection, unless it could be shown that it is really possible to accomplish with the knife in a few minutes that which nature effects in months or years, viz. to separate the periosteum from the diseased bone along with the blastema which will reproduce the part removed.

Excisions in particular.

Excision of the shoulder, as the term is ordinarily used, is intended to signify merely the removal of the head of the humerus. The operation is practised in preference to amputation at the shoulder-joint in cases of gun-shot wound or compound dislocation, when the injury is not too extensive; and is the only operation admissible in chronic disease of the joint. But in cases of rapidly growing tumour of the head of the bone, amputation would seem the more prudent course; and still more so, if the tumour were known to be cancerous. In ankylosis,—an affection which is rare in the shoulder,—no operation is admissible.

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* Some writers speak of subperiosteal resections of joints in such terms that one is almost disposed to think that they imagine the possibility of dissecting out the end of the shaft of a large bone, like the femur or the humerus, and leaving behind a sleeve of periosteum, which is to reproduce the bone. Such an idea is preposterous. The attempt would only result in leaving some irregular shreds. M. Ollier's experiments show that such shreds will, in the lower animals, produce irregular nodules of bone. Probably this would not be so in man; but if it were, such nodules would be more often in the way than otherwise.

The head of the bone may be removed, if there is not much thickening over the joint, by a single incision running downwards as far as may be judged necessary from the upper part of the acromion process, over the most prominent part of the head, where it is most plainly felt beneath the skin. This line of incision corresponds pretty nearly to the direction of the long tendon of the biceps muscle. In most cases, however, it is necessary to make a flap out of the deltoid muscle, of a somewhat triangular shape, with its base upwards. The precise position of the incisions which bound this flap is a matter of secondary importance, and is usually determined by that of the sinuses or wounds. The head of the bone, having thus been exposed, is to be rotated (when the shaft is entire) first outwards, in order to stretch the tendon of the subscapularis, then inwards, to make tense those attached to the greater tuberosity; these tendons are to be divided, and the capsule thus freely opened, and then the head of the bone is to be thrust out of the wound, and sawn off. If the case is one of injury, and the head of the bone is severed from the shaft, it must be seized with the lion-forceps, and dissected out. The bleeding is usually free, from the posterior circumflex artery or its branches. If the long tendon of the biceps can be distinguished, it should be spared. In both disease and injury, the glenoid cavity often escapes; but if it should be found affected, it may be thought necessary to remove it. This is best done with bone-nippers, or the gouge may be used. The parts should be lightly put together by means of a few sutures, and the patient confined to bed for the first few days, until the consecutive fever has passed over. He may then be allowed to move about, the elbow being carefully supported. The tendency of the muscles, which form the flaps of the axilla, to displace the bone may be counteracted by a pad in the armpit.

The amount of bone which may be removed in cases of injury, with a prospect of preserving a useful limb, appears to be considerable. Four or five inches of the bone have been removed with good result.* But no doubt the less that can be taken away the better. In cases of injury, provided all the comminuted portion is removed, fractures or fissures running down from the chief seat of injury may be disregarded. In chronic disease of the joint, the affection is usually limited to the head, except in cases of necrosis; but in necrosis it is more usual to find the shaft only diseased, and the joint exempt.*

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* Hodges, op. cit. p. 26.

The amount of motion obtained after the most successful resection of the head of the humerus does not seem so great as that which is recovered in some cases of ankylosis after disease. The arm can never, as it seems, be elevated beyond the horizontal line; while in many cases it hangs down, without any power whatever in the deltoid, at a greater or less distance from the scapula. But the movements of flexion, extension, and adduction, are usually free; abduction can often be effected to the extent of raising the arm considerably from the side; and there is usually sufficient power in the fore-arm to carry heavy weights, and perform many of the ordinary domestic tasks. The arm is therefore a very useful one, irrespective of the vast importance of preserving the hand; and so the patient is enabled to follow many of the ordinary trades. It does not appear that any advantage is gained by removing the glenoid cavity; while, as far as can be judged,† the operation is rendered more severe and more dangerous to life. Hence, unless disease is clearly present in that part, it should be let alone. "The average length of time," says Dr. Hodges, "before some use of the limb was commenced, as calculated from thirty-one of the cases in my table, was over four months; a much longer period than this was required, however, to elapse before the limb could be said to become really serviceable." The table in Dr. Hodges's treatise contains fifty cases, eight of which died, and in four others the operation was unsuccessful.

Excision of the scapula and clavicle. Excision of the scapula has been occasionally practised on account of necrosis, or the bone has been removed, together with a tumour growing from it: the excision, however, in the latter class of cases has usually been only partial, *i.e.* only the portion of the bone implicated in the tumour has been removed. The operation in such cases has usually been protracted and bloody;* and it may be added, that in most of the published cases it was of very doubtful benefit; the tumour being either of a malignant nature, and returning in spite of the operation, which did not seem to prolong life; or else being dependent on syphilis, and very probably curable without any operation at all.† These considerations,—added to the great severity of the operation in cases of rapidly growing tumour, where the large arteries which surround the scapula on all sides are enlarged for the supply of the new growth,—ought to make the Surgeon very cautious in recommending such operations. The operations on the scapula for necrosis, like all other operations for this affection, have turned out much more satisfactorily; but they bear more resemblance to the usual proceedings for the extraction of sequestra than to formal operations for excision. A case related by the late Mr. Jones, of Jersey, in the 42d volume of the *Medico-Chirurgical Transactions*, will illustrate these observations, and will show what useful motion may be preserved even after the removal of a sequestrum involving almost the whole scapula, inclusive of its articular surface.‡ No special directions are needed for these operations. The position of the sinuses will point out the most convenient directions for the incisions, which should be kept as much as possible upon the limits of the bone, in order to avoid as many of the large vessels as can be spared. The bleeding, however, in these operations for necrosis seems far less than in those performed for the removal of tumours.

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* In the celebrated case of White of Manchester, usually quoted as the first in which excision of the shoulder was performed, a large sequestrum was removed; but it does not appear that that sequestrum involved the joint; in fact, the plate in White's *Cases in Surgery*, fig. i. p. 68, clearly shows that the shaft had separated from the epiphysis, and that the part removed was the necrosed upper portion of the diaphysis.

† See the cases quoted by Dr. Hodges, op. cit. p. 34. Of the fatal cases there reported (eight in number), there was but a single instance of death where the glenoid cavity had not been interfered with.

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* See the account by Mr. Liston of such an operation performed for a tumour which he regarded as an ossified aneurism of the subscapular artery; but which was in all probability a malignant tumour of the bone. *Edin. Med. and Surg. Journ.* vol. xvi. pp. 66, 215.

† *Path. Soc. Trans.* vol. vii. p. 346.

‡ Mr. Jones's description is not perfectly clear on this point, nor is the glenoid cavity of the scapula recognisable in his drawing of the large piece of bone removed; but as he speaks of the head of the humerus as covered with its natural cartilage, in his description of the operation, which also he names "Disarticulation of the scapula from the shoulder-joint," we must conclude that the necrosed piece included, practically speaking, the whole bone, and that the shoulder-joint was destroyed in removing it. Mr. Jones accordingly describes the humerus, after the patient's recovery, as "moving freely in its new bed;" although he does not say where that new bed was formed.

Almost the same general observations will apply to the removal of the clavicle as to that of the scapula,—only, as the relations of the clavicle are far more important than those of the scapula, so must even greater caution be exercised in undertaking its removal. It is not only that very large vessels lie in the neighbourhood, which it may be difficult to avoid during the removal of a large tumour passing into the root of the neck, and perhaps lapping over them; but also that the removal of such a tumour from below the deep fascia of the neck,—for that fascia must, in most cases, be cut through,—involves alarming risk of death from diffuse inflammation. The benefit to be derived from such an operation ought therefore to be most clearly proved before its dangers are encountered.* In operations for necrosis the proceeding will be far more simple, and is likely to be far more successful. The sequestrum will probably be separated from the subclavian vein and the deeper parts by a deposit of new bone, and the patient will have a fair chance of permanent recovery. In operating on the clavicle for a tumour, the incisions should be made very free, one over the long axis of the bone, joined by others in appropriate places for turning down such flaps as may appear necessary, and the parts to be operated on should be brought fairly into view before the bone is meddled with. After having freely divided all the superficial attachments of the bone and tumour, the next step is to divide the outer end of the clavicle from the scapula, either by cutting through the joint, or by severing the bone with a small saw or nippers. Then the part which is to be removed can be raised, and must be separated with great care from the important parts which lie below it, so as to reach the sternal part, which is last divided, and which serves during the operation as a pivot on which the bone can be moved and supported; or, in other cases, it may be found more convenient to divide this part of the bone also at an earlier period of the operation.† It appears that very useful motion may be recovered after the removal of a large part, or even the whole, of the shaft of the clavicle.

After amputation at the shoulder-joint, the scapula has been extirpated for recurring disease, and portions of the clavicle have been simultaneously removed. One case is on record in which

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* In Mott's case the operation lasted *four hours*, and thirty vessels were tied. Mott says, "this operation far surpassed in tediousness, difficulty, and danger, any thing which I have ever witnessed or performed."

† See Travers, in *Med.-Chir. Trans.* vol. xxi.

Mussey, of Cincinnati, is said to have removed the whole clavicle and scapula for a tumour recurring after amputation at the shoulder-joint.* The patient survived the operation. No directions can be required for the performance of an operation which (if it were ever judged advisable to repeat it) must vary in its steps according to the condition of the parts left behind after the amputation. Mussey commenced from the inner side, so as to expose and tie the subclavian artery early in the operation; and this would probably be the best course if the state of parts should allow of it. He nearly lost his patient from the passage of air into the subclavian vein. As the original account terminates immediately on the first convalescence of the patient, and no subsequent details seem to have been published, it is impossible to say whether any benefit resulted from this formidable operation.

Excision of the elbow for disease may be thus performed. The bones are exposed by a free vertical incision, the centre of which is at the external condyle of the humerus. This is joined by a cut perpendicular to it over the tip of the olecranon, not extending inwards far enough to endanger the ulnar nerve. If more room is wanted, it may be obtained by making another vertical incision, so as to form the letter H, but the ⊢ incision is generally sufficient; and where very little thickening exists, the operation may even be completed with a single vertical incision. If the head of the radius is found dislocated on the back of the outer condyle (a very common condition in chronic disease of this joint), it may be removed at once with the bone-nippers. The joint should now be freely opened by dissecting round the olecranon, care being taken to keep the edge of the knife close against its inner side, in order to avoid the ulnar nerve, which is usually hidden from view amongst a mass of indurated cellular tissue. The end of the humerus should then be cleaned and turned out of the wound; the tip of the olecranon having been previously cut off, if the latter proceeding be found difficult. However slight the disease in the bones may be, the whole end of the humerus just above the condyles ought to be removed. Afterwards the sigmoid cavity of the ulna should be sawn away. It is better, when it can be done without inconvenience, to make the sections of the two bones of the fore-arm on the same level. The transverse portion of the wound should be accurately adjusted with silver sutures, in order to avoid, if possible, a broad cicatrix there, which might interfere with motion.* The vertical part may be brought together more lightly. The limb should then be lightly bandaged on an angular splint, before the patient is restored to consciousness.† If troublesome hæmorrhage occurs from the articular arteries at the beginning of the operation, an assistant should compress the brachial, and any vessel which continues to bleed after the removal of the bones should be carefully tied.

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* *Amer. Journ. of Med. Sc.* vol. xxi.

The extent of bone which may be removed in an excision of the elbow is considerable; in fact, within the proper limits, it seems as if the more bone is removed, the better is the result. If only the extreme ends of the bones be sawn off, ankylosis will most likely take place; while if the amount above prescribed (viz. the whole condyloid extremity of the humerus and all the sigmoid cavity of the ulna with the head of the radius), or even a little more on both sides, be taken away, free motion may, under favourable circumstances, be expected. An exaggerated idea, however, appears to prevail, of the amount of bone which may be excised with a prospect of preserving a useful limb. This idea has originated from confusing operations undertaken for necrosis with those for injury or chronic disease (caries). In the former, the whole shaft of a bone has often been removed, and a useful limb left. In the latter, where the periosteum must be removed with the bone, only a limited quantity of bone can be taken away. If the limits above pointed out have been somewhat exceeded, and still at the point of section the interior of the bones is obviously diseased, it is better, if the disease is not in a very advanced condition, to remove all the bone which is quite disintegrated, preserving what is merely softened, and thus give the patient a chance of saving his limb; but if complete disorganisation extends far into the shaft, it is advisable to amputate. The position of the line of section in relation to the junction of the epiphysis is a matter of subordinate importance in this joint, since it is of much more importance to obtain a flexible but firm union, so as to allow of good motion, than to avoid any amount of shortening of the affected arm.

The arm should be left perfectly quiet for a few days, in the position in which it has been placed after the operation. A good deal of irritative fever often supervenes. When it is necessary to change the dressings for the sake of cleanliness, a grooved splint should be applied, which will lodge the arm and fore-arm, and which is jointed in the centre and movable by a rack and pinion; with this apparatus, the arm may easily be got into such a position as will afterwards be useful, by gradually changing the angle. Passive motion, however, of a more vigorous kind must not be neglected, the time at which it is commenced varying with the state of the wound and the quantity of the bone which has been removed. If much has been taken away, ankylosis is little to be apprehended; otherwise, at a period which may be roughly stated at about three weeks, daily passive motion ought to be commenced. In the most favourable cases a very perfect false joint succeeds to this treatment; and an amount of motion is regained, which for practical purposes is little inferior to that of the original joint. Of this a very interesting example is recorded by Mr. Syme,* in which he had the opportunity of dissecting the new joint, nine years after the operation, which had been performed on account of injury,—the man having in the interval acted as guard on a railway, swinging himself from one carriage to another while the train was in motion, with the injured arm, quite as easily and securely as with the other. The ulna was found united to the humerus by ligament; the end of the radius was polished off, and played on the humerus and on the ulna, a material something like cartilage being interposed. The ends of the bones of the fore-arm were locked in by two processes projecting downwards from the humerus, and strong lateral, and still stronger anterior and posterior, ligaments also bound them to the latter bone. Union is, however, seldom so perfect as this, and the bones seem to be united merely by more or less extensible ligament.† In these cases, it is said by M. Robert‡ that flexion is composed of two movements; the fore-arm being first drawn up to the humerus by the triceps, and then flexed by the action of the biceps. Osseous ankylosis ought very rarely to occur. If the ulnar nerve be injured, a good deal of wasting of the muscles and loss of motion has been observed to follow; whether as an effect of the injury to the nerve, may be doubted; still the fact should make the operator careful to avoid the nerve. On the other hand, cases have occurred to the most experienced operators, in which the nerve was wounded; and one is on record in which it re-united, and no loss of motion or other ill consequence followed.* If the patient recover, but with disease persisting or recurring in the ends of the bones, the question of again excising the diseased portions will occur. If necrosis be present, no doubt can exist of the propriety of removing the dead portions, should they be loose; but if the exposed parts of the bone be fixed, or if the disease be caries rather than necrosis, no operation should be performed while the functions of the member appear to be improving. When this is not the case, it is right to try once more to remove the diseased bone before sacrificing the arm. Even a third such attempt has been made, and, as it is said, with good results.

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* Syme, *Obs. in Clinical Surgery*, 1861, p. 52.

† Some Surgeons,—and among them, I believe, Mr. Syme (see his treatise on *Excision of Diseased Joints*, 1831, p. 70),—merely flex the arm, and apply a roller; but the support of a splint appears to give confidence, and to prevent spasmodic movements: it need not be applied at any particular angle, but merely in such a position as avoids tension on the sutures.

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* *Lancet,* vol. i. p. 231, 1855.

† Notes of the dissections of several cases, after successful excision of the elbow, may be found in Wagner *on Repair after Resection,*—translated by the writer for the New Sydenham Society, 1860.

‡ *Gazette des Hôp.* Nov. 20, 1858.

Excision of the elbow is usually considered, and in all probability correctly, as a more formidable operation in respect of mortality than amputation of the arm; but no data exist, as far as I am aware, for a correct comparison between the two. In Dr. Hodges's work there is a table of 119 cases, principally from the journals and other published sources: of these, 15 died; and in 15 others amputation was performed. In the great majority of the cases which survived, the usefulness of the limb was proved by the patient being able to resume his ordinary avocations; but the details as to the extent and kind of motions left are not exact.

In the essays on INJURIES OF THE UPPER EXTREMITY and GUNSHOT WOUNDS the reader will find the indications for amputation, excision, or entire preservation of the limb, in cases of injury. In cases of ankylosis of the elbow excision is rarely required, although where true bony ankylosis has occurred in a bad position, excision may be performed if the patient wishes it; but in bony ankylosis in the flexed position, and in all cases of soft ankylosis, this operation is inadmissible. The former ought to be let alone; the latter are under the control of the methods described in the essay on ORTHOPÆDIC SURGERY. In cases of disease of the bones of the elbow, excision is the operation which should be adopted, except under special circumstances necessitating amputation, such as unusual extent of implication of the bones, advanced age, great debility, or constitutional affection. But the rarity of such circumstances is shown by the fact, that Mr. Bryant's collection of 300 amputations† only includes 10 in which the arm was amputated for disease of all kinds. So that excision of the elbow is the operation almost universally resorted to in cases of incurable disease of that joint.

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* Syme *on the Excision of Diseased Joints*, 1831, case viii. pp. 88-94.

† *Med.-Chir. Trans.* vol. xlii.

Excision of the wrist. The operations which are described as excisions of the wrist are very generally excisions of several of the carpal bones only, or of the ends of the bones of the fore-arm only; sometimes, however, more or less of the carpus is excised at the same time with the ends of one or both of the long bones. The operation may be performed by means of longitudinal incisions on either side along the subcutaneous borders of the radius and ulna, continued on to the hand far enough to enable the operator to get at the carpus; or, as is more usual, by a transverse incision across the dorsum, joined by such lateral cuts as may seem necessary. The advantage intended to be obtained by the former method is the preservation of the tendons; but in so many cases they are either previously or subsequently matted down to the bones or cicatrix by inflammation, that the benefit resulting has not been proportioned to the complexity and difficulty of the operation; so that the second plan is in more frequent use. But perhaps no formal directions need be given for this operation. In cases of limited injury, such as a gunshot wound, where some of the bones of the carpus, or the ends of the bones of the wrist, are comminuted, but without sufficient destruction of soft parts to necessitate amputation, or preclude the prospect of saving one or more flexible digits, it is proper to enlarge the wound, and dissect out the loose portions of bone, when this can be done without further mischief to the apparatus of motion. In like manner, in the very rare event of limited disease existing in this part, it might be proper, after bestowing a patient trial on the usual means of cure, to enlarge the sinuses, and gouge out the affected bones; but no operation appears advisable when the whole carpus is involved in chronic disease. The patient will probably recover from the disease in the course of time, unless the strumous cachexia is too far advanced; while if it is so, he will not recover from the operation any more than from the disease. Nor does it seem in the least degree probable that he will have better motion after the operation than after the natural cure. Consequently the formal excision of the whole wrist for extensive disease (which is almost always strumous) is an operation which is regarded with little confidence even by those who are the most zealous advocates for excision of other joints.

Excision of single bones of the hand. Though the excision of the wrist-joint is an operation of doubtful benefit, and one which can seldom be performed, on account of the strumous cachexia in which the disease originates, and the probable loss of all useful motion which will follow the operation, still the excision of some of the bones of the hand may be practised with advantage, especially if the tendons are unaffected and can be secured from injury in the operation. It is of especial importance to preserve the thumb by the timely excision of its metacarpal bone or first phalanx when universally diseased; and the benefit of resecting the diseased portion, and leaving the articulating head, is of course still greater. If the periosteum can be spared, there will be in all probability a more firm union between the severed ends of the old bone, in consequence of the production of osseous granules, or even larger pieces of bone, in the cicatrix; but I am not aware of any facts which prove that such excised portions are ever really reproduced. It is of little use to remove the phalanges of the fingers (except those of the terminal row), unless in a few cases where they are necrosed and loose, for the formal excision of these bones would almost invariably leave a useless finger. But occasionally, especially when the extensor tendons can be spared, the metacarpal bones may be made the subjects of operation; and here, as well as in the thumb, it is of much importance, if the extent of the disease allows it, not to open either joint, particularly the phalangeal.

No precise directions are necessary for such operations, which consist merely in exposing the diseased bone on its dorsal aspect, scraping off from it all the soft parts, including the periosteum if possible, dividing the bone with cutting forceps (the extensor tendon being held out of the way), then seizing the divided end with the lion-forceps, cleaning the bone on the lower surface, with much care not to dip the point of the knife into the palm, and finally, when the limit of the disease is reached, nipping off the bone. If the extensor tendon has been unavoidably severed, the finger must be carefully supported on a splint till this has reunited. In case of disease of the two middle metacarpal bones, it will be better to remove the diseased portions with a small chisel; and this plan is preferred by many Surgeons in the other metacarpal bones also, in order to preserve the periosteum. I have already given my reasons for preferring, in general, the method of dissecting out, to that of gouging out, carious bones.

Excision of the hip is an operation, of the value of which the most widely differing estimates have been formed by different Surgeons. Nor is this surprising, when it is considered that the disease for which it is usually undertaken is accompanied by exhausting and long-continued suppuration, rendering the prospects of surgical operation unfavourable; while, on the other hand, recovery is so common that it is impossible in any case which gets well after operation to affirm with certainty that the natural cure was impossible. The operation is performed on account of gunshot wounds, or in advanced strumous disease, accompanied by abscess, where the patient seems in danger of dying of hectic, and the ulceration of the bone is judged to be incurable. The hip-joint ought never to be excised on account of deformity from ankylosis, although it may be advisable in appropriate cases to divide the neck of the femur, or even to cut a wedge-shaped piece out of it.* The operation of excising the hip, as it is commonly spoken of, means merely the removal of the head of the femur: but the acetabulum may also be removed, if it be thought necessary. The operation differs considerably in difficulty, according as the head of the bone is or is not in the acetabulum, and according as the Surgeon does or does not require to obtain access to that cavity in order to remove its floor. In most cases of chronic disease the head of the bone has undergone that process of displacement usually, though not very accurately, spoken of as *dislocation*,—*i. e.* the lip of the acetabulum has been ulcerated or absorbed, and the head of the bone (also altered in shape from ulceration) lies partly on the dorsum ilii, partly on the edge of the expanded acetabulum, and is very probably covered by few if any muscular fibres, since these have become atrophied from disuse; the ligaments also have in a great measure disappeared. All that is necessary in the operation is to make an incision of sufficient length over the prominence of the bone, running somewhat behind the trochanter, and, having exposed the head of the bone and turned it out of its cavity, to saw it off at such a level as the extent of the disease seems to indicate. When, however, the head of the bone remains in the joint, and the ligaments are entire, as is the case generally in excision for injury, and in a few of those for disease, the operation is not quite so simple; and it becomes still more difficult if the neck of the bone is fractured, so that the Surgeon cannot get any purchase upon the head to turn it out of the acetabulum. In such cases an incision must be made, running behind and parallel to the posterior border of the trochanter, and long enough to admit of free access to the joint. The length will of course vary according to the size of the buttock, but it may be stated in general terms that the incision should commence near the junction of the trochanter and the shaft, and should curve (with its convexity backwards) round the prominent upper border of that process. By cutting now along the neck of the femur, the situation of the joint may be accurately ascertained, if it has been hidden by swelling from disease or injury; and, that having been done, the parts may be divided from within outwards in any direction which may seem convenient (according to the presence of wounds, &c.), so as to render the external incisions crucial or T-shaped. The flaps are now to be reflected. If the neck of the femur is fractured, the fractured part is to be seized with the lion-forceps, and cleared up to the head and round it, and so removed. Search should then be made for shots, foreign bodies, fragments of bone, &c. If, on the other hand, the neck of the bone is entire, and sufficiently strong to bear the requisite force, it may be more convenient to turn out the head of the bone, and divide the ligaments, as in ordinary exarticulation; otherwise the neck may be cut through with a keyhole-saw. This instrument should always be at hand, together with a trephine, elevator, gouge, &c. for removing impacted foreign bodies, or for clearing the acetabulum.

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* See p. 614. I once saw a case in which the hip was fixed in acute flexion. The symptoms induced the Surgeon in charge of the case to perform an exploratory operation; but on cutting down, the joint was found perfect. The neck of the femur was sawn through, and the thigh placed on a straight splint. The patient (a child) recovered, with a straight and useful limb.

Opinions differ as to the expediency of preserving the trochanter in excisions of the hip. Most Surgeons would not remove the trochanter unless it was affected with disease, as the limb would appear more likely to enjoy precision and freedom of movement if the numerous attachments of important muscles around that process were left undisturbed; besides which, the amount of bone removed in excising the head and neck of the femur is already considerable; and if to this the whole extent of the trochanter be added, a serious risk of a flail-like union is incurred. The supposed advantage of removing the trochanter is to avoid the risk of that process being displaced into, and so interfering with the union of, the wound.

Thus far we have spoken only of the removal or decapitation of the head of the femur; but since the acetabulum is freely exposed in this operation, it is possible to carry it further, and remove part, or the whole, of the floor of that cavity; and this has been often done with success. In Mr. Barwell's treatise on *Diseases of the Joints*, p. 444, the reader will find an interesting account of a case in which Mr. Hancock removed the whole of the floor of the acetabulum, together with the head of the femur; and where, on the death of the patient, nineteen months after the operation (his limb having been useful in the mean time, although some disease still existed in the bones), an opportunity of dissecting the parts was presented. Mr. Erichsen removed not only the whole floor of the acetabulum, but also the ramus of the pubes and ischium, with part of the tuberosity of the ischium and a portion of the dorsum ilii; and reports that the patient had a useful limb.*

The statistics of this operation are of little real value, nor are they of the same importance as in those excisions where the question lies between the removal of a joint and of a whole limb. The rate of mortality is extremely high; so that out of 111 cases collected by Dr. Hodges,† in which the result was known, 56 recovered "with more or less useful limbs," 53 died of the combined effects of the operation and the previous disease, and in the remaining two cases amputation was performed. But it is impossible to deduce any exact conclusion from such facts as these; since, without a personal knowledge of each case, no opinion as to the probability of recovery without operation can be formed. The average duration of treatment in those cases in which the point was noted (49 in number) was 230 days. The high mortality and the very protracted period of convalescence certainly show that, even in those severe cases of hip-disease which alone are selected for this operation, the patient's prospects are not materially improved by it, although it must be allowed that the concurrent testimony in its favour of many eminent Surgeons, who have had ample opportunities of watching its effects, justify a resort to it in cases which seem otherwise hopeless. The immediate effects of the operation are not often fatal, and it is, to say the least, extremely probable that where there is great and exhausting pain from pressure of the diseased bones on one another, the operation may save life. The greatest care, however, should be bestowed on the diagnosis of any case in which excision is contemplated. There are few instances of advanced hip-disease in which the external surface of the pelvis is not more or less involved; and this fact (which may be judged of partly by the direction of sinuses, partly by the grating sensation elicited by passive motion under chloroform) forms no insuperable objection to the proceeding; but abscess communicating with the interior of the pelvis near the joint (in spite of the extensive removals of bone practised by Mr. Hancock and others), and still more with remoter parts of the pelvis, or extensive disease of the femur, or the presence of other strumous affections, ought to be regarded as forbidding the attempt.

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* *Science and Art of Surgery*, 3d ed. p. 745.

† Op. cit. p. 116.

The amount of motion recovered is seldom great. On this point, again, the statistics fail to afford any reliable information; but it may be safely asserted that the limb is more likely to be useful after natural recovery in the extended position than after any operation. So that excision ought never to be attempted unless, with disease still progressing, the joint-surfaces are hopelessly displaced (a very rare occurrence), or the Surgeon, on a careful review of all the symptoms, has strong reasons for concluding that natural recovery is impossible. When the operation is once decided upon, it should not be delayed till the patient's health has given way, but should be performed at once.

Excision of the knee has been practised more frequently than that of any other joint, except the elbow; but the opinions of Surgeons are by no means so unanimous on the former subject as they are on the latter; for whereas no one denies that amputation of the arm should only be resorted to in exceptional cases of disease and injury of the elbow, many (perhaps I might say without inaccuracy almost all) hospital Surgeons, in this city at any rate, think that amputation is advisable in the majority of the affections of the knee; while some have never yet performed the excision of that joint. There are many reasons why excision should be less successful in the knee than in the elbow. Firm bony ankylosis is required in the lower extremity; the treatment involves many weeks of strict confinement to one position; the surfaces of bone sawn through are very large; the cavity of the wound is badly situated for union; the epiphysal lines are near, and if trenched upon in young subjects, the growth of the limb may be suspended; the operation is more severe than excision of the elbow; and finally, the advantage of preserving the foot, although considerable, is far less than that of retaining the hand. It is not likely, therefore, that this operation will ever come into such favour as that on the elbow; still, though it has been vehemently decried, and though its general adoption has possibly been equally retarded by its having been vehemently overpraised, it seems likely to hold a permanent place among the resources of operative Surgery for the treatment of appropriate cases.

The acceptance which this operation has met with is not due to its lower rate of mortality. It has been clearly shown by the statistics collected by Dr. Hodges,* that in general practice the mortality has been about one-third; a far higher average than that after amputation at the lower third of the thigh for chronic disease of the knee; and from what I can learn of the statistics of metropolitan hospital practice, I believe the same rate of mortality has prevailed.† But this only imperfectly represents the ill-success of the operation; for if to those who have died we add those whose limbs have been amputated, or have remained useless, we shall find that the failures after the operation at least equal the successes. In spite of this known fact, however, it seems to be the growing conviction of hospital Surgeons that the operation ought to be introduced into practice.‡ This conclusion must rest upon other considerations than those of the mere mortality after amputation and excision. It is not very probable that excision of the knee will ever be less fatal than amputation. There is no conceivable reason why it should be so. It is sometimes said that the hæmorrhage is less; but I am far from convinced of this. The blood *shed* in an amputation is always greater than in excision; the blood *lost* is frequently less, for in a well-managed amputation the blood which gushes out is only that which was circulating in the amputated part, and little else is really lost to the system. In excision the operation is often a bloody one (though sometimes not so), and secondary hæmorrhage is by no means rare. Then it is said that the wound is smaller than in amputation; but though the *surface* of the wound is smaller, its cavity (which is at least as important) is larger. The immediate shock, as far as I have seen, is generally considerable; quite as much so as in amputation.§ The surfaces of bone exposed are very large, and the union of this great compound fracture, and the filling up of the large cavity left by the operation, call for considerable reparative power, and entail dangers from which amputation is exempt. But what has really brought excision of the knee into practice, and has compensated for the failures induced by its indiscriminate adoption in all kinds of cases, is its striking success in cases which are fitted for it; and it is, therefore, to the discovery of rules whereby such cases can be diagnosed, that the efforts of those who wish to promote this operation should be directed. The space which an adequate discussion of this matter would require not being here at my command, I must be excused for expressing summarily what I believe to be the correct indications for the performance of excision of the knee, as far as our present experience will enable us to lay them down.

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* Op. cit. pp. 142-8. † See *Brit. and For. Med.-Chir. Rev.*, July 1862.

‡ Those who judge only from journals and books may think that I speak too dubiously of the support afforded to this operation; but the real unanimity of the profession in the matter may be judged of from this fact: up to the end of 1861, as far as I can learn, four excisions of the knee had been practised at St. Bartholomew's and Guy's Hospitals, while nearly fifty had been done at King's College and University College. Considering, therefore, the relative size of the hospitals, the operation was more than fifty times as common at the latter as at the former institutions.

§ I am informed by Mr. Henry Smith that in more than one fatal case at King's College Hospital death has been attributed to the shock of the operation.

Excision of the knee should never be performed in elderly persons.* They have not usually the requisite reparative power; and the advantage over amputation is not sufficient, even in the most favourable case, to balance the increased risk. There are many reasons also against performing the operation in very young children: such as the probability of recovery without operation, if the suppurating joint be kept in a good position and freely opened; the risk of checking the growth of the limb by excision; the great probability that the joint-disease is but a symptom of constitutional mischief, in which case excision would do no good. No excision of the knee ought to be undertaken in a patient in whom there is any good reason to suspect, far less any evidence of the existence of, phthisis or any other constitutional affection. Had this simple dictate of common sense been more strictly adhered to, many of the deaths which now give so gloomy a complexion to the statistical reports of excision of the knee would have been avoided. Excision for disease should be exclusively confined to cases in which the disease is in a chronic condition. In acute abscess the operation is inadmissible. In all cases where sinuses exist, leading for any considerable distance, and generally whenever the disease is of very long duration, excision should only be undertaken as an exploratory measure, and every thing should be in readiness for amputation, if the softened condition of the bones should render the latter operation necessary; as will very probably be the case, even if no part should be found absolutely carious or necrosed. In deformity the result of old disease, if the disease have entirely subsided, orthopædic measures will most probably succeed; but if the case appears beyond their reach, no grave operation ought to be undertaken, except at the express instance of the patient; or, if a child, of his parents. The operation itself has its own peculiar difficulties and dangers in such cases; but, as a general rule, *opérations de complaisance*, as the French call them, should never be pressed on the patient. Excision for injury is very rarely required, or justified, in civil practice; since the injuries which generally occur in our hospitals,—such as severe falls, the passage of wheels over the limb, crushing by machinery, &c.—involve either very extensive fracture or large lacerated wounds. But cases of gunshot wound may, however rarely, be admitted into civil hospitals, in which a bullet, or other missile, has lodged in the articulating end of either, possibly of both, bones, without inflicting so much damage upon the neighbouring parts as to contra-indicate excision; and in some very rare cases of fracture it may be thought proper to excise the joint.* In military practice (as stated above, vol. ii. p. 84), excision is rarely feasible. The little evidence that we possess at present appears to show that the risk is about as great as that of primary amputation. It ought not to be undertaken except in young subjects, and not in them except in those rare cases where, along with an amount of injury to the joint which renders preservation of the limb without operation hopeless, there is at the same time no such extensive wound, and no such injury to the main vessels, as to necessitate amputation; and even in these rare cases it will always be doubtful whether the injury to the bones is limited to the neighbourhood of the wound, and therefore the operation is always to be regarded as an exploratory proceeding, which may terminate in amputation.

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* Speaking generally, and with due allowance for exceptional cases, I mean in persons above the age of forty-five.

The conclusion from all this appears to be, that the cases suitable for excision are those of incurable injury or disease of the knee, in which all the circumstances, both constitutional and local, are most favourable; in which the patient is in the prime of life, and free from visceral disease; and in which there is reason for hoping that the lesion has not spread beyond the epiphysal ends of the bones.

The operation is thus performed: an incision should be made from the back part of one condyle to the back part of the other, passing across the front of the limb below the patella, and slightly convex downwards. It is seldom necessary to make any other incision into the skin; but if there is much thickening about the soft parts, perpendicular incisions may be made at the ends of this, so as to form the H-shaped incision, which used always to be employed in this operation. The ligamentum patellæ is to be divided in the first incision; then the soft parts are to be thrown back from the patella and the end of the femur, and the patella is to be removed.* The joint is now to be freely opened by cutting at the sides of the condyles, so as to sever completely both lateral ligaments; and then the knife is to be carried round the posterior surface of the end of the femur, care being taken in doing this to thrust the femur out of the wound as much as possible, by an assistant forcibly flexing the limb, and to keep the edge of the knife directed towards the bone and guided by the finger, so as to avoid the popliteal artery, which here is separated from the bone only by some fat and loose tissue; and, in sawing the bone, it may be advisable, if the femur have not been very completely cleaned, not to pass the saw entirely through the osseous tissue, but rather to break than to cut the outer lamella at the back, by using the saw as a lever. The end of the femur having been removed, the head of the tibia is to be cleaned and sawn horizontally, care being taken in young persons to keep close below the cartilaginous surface, so that the epiphysal line be not trenched upon. In cases where there has been no dislocation, nor much alteration in the shape of the bones from previous disease, there is now usually no impediment to placing the limb in a straight position, with the bones in accurate adjustment. Otherwise they must be adjusted by taking off successive pieces from the end of the femur (if possible without going beyond the epiphysis); and in cases of old dislocation it is often necessary to sever some of the hamstring tendons.† The parts should, in all cases, be adjusted in perfect position upon a splint, and the bandages firmly applied before the patient is moved or allowed to recover from the chloroform. If the femur appears at all prominent, a short splint should be applied in front in order to counteract the tendency of the leg to gravitate backwards (which is also assisted by the action of the flexor tendons); and it is at any rate a useful precaution to apply a long side-splint to the outer side of the limb, which can be discarded after the first few days, if it appears superfluous. I have found much comfort to the patient from suspending the whole apparatus in a "Salter's swing." It will of course be understood that the splints are interrupted and bracketed with iron at the seat of operation, so as to give access to the wound. It is an essential element in the success of this operation not to be forced to disturb the limb at all for several days; hence the dressings should be most carefully applied at first. And for the same reason all bleeding vessels should be carefully secured, so as to avoid secondary hæmorrhage. The bleeding during the operation is often very free, from the enlarged articular vessels; and secondary hæmorrhage is by no means rare, and is a very unfavourable occurrence. The operation, especially when it has been a protracted one, which in cases of old dislocations it often is, is usually followed by a considerable amount of fever, subsiding with the establishment of a free suppuration; and then, in favourable cases, the work of repair commences by granulation and osseous union, as in compound fracture. In unfavourable cases, the bones become denuded and ulcerated in the suppurating cavity, the discharge is offensive, the wound unhealthy, fresh abscesses probably form, and the patient's health, instead of improving from the removal of the disease, shows a tendency to decline. Under these circumstances, chloroform should be administered and amputation performed, if on examination it proves necessary.

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* Mr. Canton has lately published two cases in which he performed this operation successfully for injury; or perhaps, more strictly speaking, for abscess following injury.

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* I believe no difference of opinion now exists as to the uselessness of attempting to save the patella in any case.

† I believe, after having had occasion to do it in both ways, that this is better done from the wound than subcutaneously. There is no occasion to make a hole through the popliteal space, as some Surgeons have recommended. If the principal incision has been made far enough back, there will be sufficient escape for the matter.

The process of recovery is usually a slow one. In Dr. Hodges's tables, already referred to, the duration of the treatment in 48 cases in which the patella was removed is stated to have been 225 days; and in 38 cases in which that bone is believed to have been left, 255 days; or, roughly speaking, the average duration of treatment was about eight months; and in many of the cases which afterwards turn out the most successful, sinuses remain open, and the limb is in a state which cannot but cause anxiety for many months after formal treatment is discontinued.* In some exceptional cases, indeed, matters go on much more rapidly than this, and the recovery is completed as soon as (indeed, it may be that one or two have recovered sooner than) after amputation; but, as a general rule, the time required for recovery after excision may be taken at about four times as long as after amputation. In fact, I think we are taking a view very favourable to excision, if we say, that every month after the operation advances the cure only as far as a week would after amputation.*

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* In a series of eight successful cases, all of them in children, at St. Thomas's Hospital, for the notes of which I am indebted to Mr. Allingham, the average duration of treatment was 206 days.

What is the value of the limb which is obtained by this operation, at the cost of such increased risk and so much additional suffering? Unfortunately, this is a question, the answer to which has been so distorted by the rash and exaggerated statements of the indiscriminate advocates of the operation, that no impartial person can profess to be able to solve it. I have seen, in a few cases, most excellent limbs left after excision; far superior both for appearance and utility to any apparatus which could be manufactured after amputation, and still more to the ordinary wooden leg: and it is on account of the occurrence of such cases that I believe excision ought to be practised upon the most favourable cases of disease of the knee; but I utterly disbelieve the accounts which have been published, resting upon statements in newspapers and periodicals, of cases, many of which had not recovered from the operation, while in a great proportion the sinuses were still open, and the patient in about an equal chance of saving his limb or losing it. No case is to be accepted as a successful one of excision of the knee, without *precise* information as to the following facts: Whether the wounds were all closed; whether the union was so firm as no longer to permit any motion; whether the patient could walk, and if so, with or without apparatus; and what were the respective measurements of the limbs. It is true, that to have waited long enough to satisfy these queries would have somewhat delayed the appearance before the world of some brilliant cases, and perhaps have condemned many of them to perpetual obscurity; but, on the other hand, it would have made the information, when it did appear, useful and trustworthy, instead of, as at present, either useless or deceptive. As far as Dr. Hodges could discover, from the data furnished by published accounts, out of 208 cases of excision, 102 failed utterly, as proved by death or amputation; and of the remaining 106, there was reason for thinking that in 65 cases the limb was useful, and in 14 partially or entirely useless; 27 being left quite doubtful: but from the nature of such accounts this conclusion cannot be a very confident one. Out of 19 cases occurring at St. Thomas's and St. George's Hospitals together, of which I have trustworthy and sufficient details, the limb was useful in 10 cases; but 9 of these were children.

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* From the notes of 50 successful amputations of the thigh, at St. George's Hospital, I find that the average stay in hospital was 53 days. This includes patients of all ages. Children and young persons, such as are alone the subjects of excision, recover more rapidly than the average.

Another very serious consideration in cases which recover with useful limbs is, whether that usefulness will be permanent. It is now a well-known fact, that the utility of the limb in many cases in which it seemed perfect at first has been destroyed by subsequent changes. In adults, the union, although it has appeared quite firm, sometimes proves not to have been so, and the limb bends under constant use, and yields to the power of the flexor muscles, until the foot no longer touches the ground, and the whole extremity becomes an incumbrance instead of a support. Sometimes it bows outwards or inwards, but with the same general result. Occasionally disease recurs, after a shorter or longer interval of apparent health, either spontaneously or as a consequence of some accidental injury or over-exertion. In children, suspension of growth may ensue as a consequence, in most cases,* of removal of the entire epiphysis, and encroachment on the shaft, of one or both of the bones.

If the limb be simply bent in consequence of soft union, the only treatment required is to straighten it under chloroform, and keep it straight in a carefully-fitted splint for some months, with due attention to the general health, the patient being put in good pure air, and allowed to take moderate exercise upon crutches. When disease is present in the bones, it becomes a question whether the diseased bone can be removed, or whether the limb should be amputated. Some Surgeons have even proposed the complete re-excision of the false joint by an operation similar to the original one,—a proposition highly worthy of consideration if the patient has attained his full growth and is in good health, and the shortening left by the first operation is not great. Such reëxcision must, however, always be proposed to the patient as an exploratory operation, which in many cases will have to terminate in amputation.

Excision of the ankle-joint has been proposed as a substitute for amputation of the foot in disease of the ankle;† and it cannot be denied that some successful operations have been performed, although the great majority seem to have terminated in disappointment. Before performing or proposing this operation, the diagnosis of disease strictly limited to the ankle-joint should be made; and this is not always easy to do. If the astragalus be deeply affected, still more if the os calcis be involved, as proved by the number and direction of the sinuses, it would be wrong to attempt excision. I do not mean to deny the possibility of removing one or more of the tarsal bones together with the ends of the bones of the leg;* but amputation at the ankle-joint is preferable, the certainty and the celerity of the cure far outweighing any possible advantage from preserving a foot so mutilated. Even in disease limited to the ankle-joint, I have hitherto only practised (or seen practised) amputation through the joint; but there seems no doubt that some cases of successful excision have occurred at Charing Cross Hospital;† so that I cannot do better than quote Mr. Barwell's description of the operation which has been found to succeed. "The foot is first laid on its inside, and an incision is made over the lower three inches of the posterior edge of the fibula. When it has reached the lower end of the malleolus, it forms an angle, and runs downwards and forwards to within about half an inch of the base of the outer metatarsal bone. The angular flap is reflected forwards; the fibula, about two inches above the malleolus, is sufficiently cleared of soft parts to allow cutting forceps to be placed over it; and the bone is then nipped in two, and carefully dissected out, leaving the peroneus longus and brevis tendon uncut. The foot is now to be turned over. A similar incision is made on the inner side, the portion on the foot terminating over the projection of the inner cuneiform bone. The flap is to be turned back, and the sheaths of the flexor digitorum and posterior tibial tendons divided, the knife being kept close to the bone, avoiding the artery and nerve. The internal lateral ligament is then to be severed carefully, close to the bone; and now the foot is twisted outwards, and the astragalus and tibia will present at the inner wound. A narrow-bladed saw, put in between the tendons into the inner wound, projects through the outer. The lower end of the tibia, then the top of the astragalus, may be sawn off in a proper direction. The only vessel that may require tying, is one of the lower branches of the peroneal artery.

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* Suspension of growth has, however, been noticed in one case at least, under Mr. Syme's care, where the epiphysal lines appear to have been left intact.

† I do not speak here of resection of the projecting ends of the bones in compound fracture or dislocation. This is treated of in the essay on Injuries of the Lower Extremity.

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* In one case referred to by Dr. Hodges, the ends of the tibia and fibula, the whole of the astragalus, part of the os calcis, and the three cuneiform bones, were removed; in another the end of the tibia, the astragalus, scaphoid, and two of the cuneiform.

† Barwell *on Diseases of Joints*, p. 464. In many other cases success is claimed; but in by far the greater number of them, it is clear that the sinuses were unhealed, and when they are so, the foot is never safe. Mr. Statham's case, in the *Medico-Chirurgical Transactions*, is an example. It is reported as successful, but the foot was afterwards amputated.

"The wound may be closed with sutures, except that part opposite the breach of osseous matter; the leg and foot placed on a splint with a foot-board, and cold water applied. No shock follows the operation. The patients get well very quickly; a fact which may be in part attributed to there being no necessity for rigid confinement, as in other large joints of the lower extremity."

With reference to the last statement of Mr. Barwell's description, it is hardly borne out by the records of published cases. In Dr. Hodges's work nineteen cases will be found in which recovery is claimed, and the time of treatment given. In all of these the duration of treatment exceeded three months, and in the great majority it was far longer than this; reaching in one case to *three years.* In all the cases in which the report is given at an earlier period (one month, six weeks, ten weeks), the patient is only said to be "recovering." In a case alluded to in Mr. Barwell's work, the patient is said to have been able to walk several miles every day within ten months after the operation. It is to be regretted, however, that in this, as in almost every other case, the precise condition of the parts is left undescribed.

Dr. M. Buchanan has also described* an operation for excising the ankle-joint, by making a curved incision over the external malleolus, removing this process with the bone forceps, dislocating the joint by inverting the sole of the foot, and thus obtaining access to the diseased bones without dividing any important parts, the peronei tendons being the only structures necessarily divided. This proceeding is merely a portion, as it were, of the one described by Mr. Barwell. It cannot give so free an access to the bones as is obtained by the former; but it may be adopted in cases where the end of the tibia does not require entire removal with the saw. The operation may, therefore, be commenced by making merely the incision on the outer side; and then, if it be found necessary, that on the inner side may be added.

Excision of the bones of the foot. In disease of the tarsal or metatarsal bones excision is often very successfully practised when the disease is limited to the os calcis behind, or to single bones of the metatarsus in front; but it is of more doubtful utility when the bones which are affected are those covered by the large common synovial membrane of the tarsus. These bones, both from their small size and from being portions of the same joint, are very liable to become involved in the same action; and thus it frequently happens that disease is only eradicated at one point to show itself some weeks afterwards at another, and the attempt to save the foot is often unsuccessful. But in favourable cases it ought to be made, since the operations involve little danger, and no confinement beyond what would be rendered necessary by the disease itself. Many Surgeons prefer gouging out the whole carious cavity, leaving a shell formed of bone presumed to be healthy, and of the soft parts around; an operation sometimes dignified by the name of "subperiosteal resection." The alleged advantages of this proceeding are, that the bone may be reproduced, and that the great tendons will be left in their natural attachments. I do not attribute very much importance to either of these considerations. No direct evidence, as far as I can discover, has been given that the natural bone will be reproduced after such gouging. I mean by "the natural bone," a bone which will fill up the place of the original bone, and have the same articulations; and by "direct evidence," the dissection of a foot in which this has taken place. The disadvantages are all of them summed up in the fact of the difficulty of being sure that the whole of the diseased bone has been removed. When the whole of the os calcis, or of the first metatarsal bone, has been involved, except a small exterior portion of dubiously healthy bone, I have not scrupled to dissect out the entire bone without respect to the periosteum, and have seen no reason to repent having done so. The foot has been left in a very serviceable condition; and I much doubt whether the addition of a few detached pieces of bone to the cicatrix (which I believe would have been the entire result if the periosteum had been left behind) would have affected the usefulness of the foot in any way.

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* *Glasgow Medical Journal,* vol. ii. p. 1.

The removal of the os calcis is an operation which may often be practised with great advantage. Disease of the tarsus very commonly begins in the joint between the calcaneum and astragalus, and frequently spreads into the former bone; the affection of the latter being so superficial that the carious spot can be gouged away when the greater mass of disease has been removed. In these cases, the central part of the calcaneum often perishes, leaving a large mass of necrosis enclosed in a thin-walled cavity of inflamed and softened bone. If now the whole bone, including this shell of softened bone, be removed, the patient makes a certain and speedy recovery with a useful foot; while, if the loose portion be removed, and the shell scooped, he may, it is true, recover, and the heel may possibly be more firm; but the recovery is certainly more doubtful, and in the course of a tedious convalescence the health may give way, fresh disease be lighted up, and amputation become necessary.

Excision of the os calcis is thus performed. An incision is commenced at the inner edge of the tendo Achillis, and drawn horizontally forwards along the outer side of the foot, somewhat in front of the calcaneo-cuboid joint, which lies midway between the outer malleolus and the end of the fifth metatarsal bone. This incision should go down at once upon the bone, so that the tendon should be felt to snap as the incision is commenced. It should be as nearly as possible on a level with the upper border of the os calcis; a point which the Surgeon can determine, if the dorsum of the foot is in a natural state, by feeling the pit in which the extensor brevis digitorum arises. Another incision is then to be drawn vertically across the sole, commencing near the anterior end of the former incision, and terminating at the outer border of the grooved, or internal, surface of the os calcis, beyond which point it should not extend, for fear of wounding the posterior tibial vessels. If more room be required, this vertical incision may be prolonged a little upwards, so as to form a +. The bone being now denuded, by throwing back the flaps, the first point is to find, and lay open, the calcaneo-cuboid joint; and then the joints with the astragalus. The close connexions between these two bones constitute the principal difficulty in the operation on the dead subject; but, as has been already stated, these joints will frequently be found to have been destroyed in cases of disease. The calcaneum having been separated thus from its bony connexions by the free use of the knife, aided, if necessary, by the lever, lion-forceps, &c., the soft parts are next to be cleaned off its inner side with care, in order to avoid the vessels, and the bone will then come away. The flaps are to be closed lightly, with one or two points of wire-suture, over the large gap left by the excision.

This plan appears more convenient and less bloody than that recommended by Mr. Hancock and Mr. Guthrie, of making a flap from the heel and throwing it up, as is done in Syme's amputation. Even if the diagnosis has been erroneous; if disease should become apparent in the astragalus or in the fore-part of the tarsus, when the bones are denuded, and so the Surgeon should be led to amputate the foot, that operation could be easily accomplished by a slight extension of the incisions just described. In this way I have removed the os calcis in a child in a very short time, and without finding it necessary to tie a single artery. The filling up of so large a cavity is of course a rather tedious business; out of several cases in children, of which I have notes, I find none in which it was completed in less than three months; and probably the child does not recover the power of putting the foot to the ground for another month or more. But when it is soundly healed, the foot is a very useful one; and I have seen children who could run, dance, &c. pretty nearly as well as with the natural foot.

No formal directions are required for excising the other tarsal bones. The soft parts are to be thrown aside by crucial incisions, radiating from the sinuses which lead to the diseased bone, and the latter removed; care being taken, in all cases where it is possible, to excise the whole bone with the articulating surfaces.

The metatarsal bone of the great toe is very often diseased; and from its large size disease may go on in its substance for a long period without affecting any other bone. In such cases, after a sufficiently patient trial of the appropriate constitutional treatment, with rest, it is proper to expose the disease; and if this is found to include the greater part of the bone, then the best course is to remove the whole, with both its articular surfaces. This may be readily done by making an incision over the whole length of the bone, joined by shorter perpendicular cuts in front and behind, and thus turning back small rectangular flaps including the whole length of the bone. It is better to commence by severing it from the cuneiform bone, as in dividing it from the phalanx the plantar arch will most likely be wounded, and the bleeding may prove somewhat embarrassing; whereas if the artery be not divided till the bone is removed, there is no difficulty in tying it. No splint is required. The great toe sinks down somewhat towards the tarsus, but the foot is as useful in progression as before.

Should single metatarsal bones in the centre of the foot be diseased, it is better to gouge away the whole of the diseased part; or if the affection seems too extensive, to amputate the toe, and dissect out the metatarsal bone from the posterior end of the wound.

The above are all the operations of excision, which it seems necessary to describe particularly. Dr. Humphry has removed the condyle of the jaw (see p. 795); and the same Surgeon on one occasion excised a fractured portion of the patella: but the superficial position of these bones, and the rarity of the operations, render any formal description superfluous.

The operations on the upper and lower jaw will be described in connexion with the surgery of that part of the body.

Partial resections of long bones. When the entire thickness of a long bone is diseased, it may sometimes be advantageous to remove the diseased portion only. In this way portions of the ribs have been resected on account of caries, probably in order to avert the occurrence of pleuritic inflammation from the neighbourhood of the diseased bone; an operation of some risk and very doubtful utility. Or portions of the shafts of the ulna, radius, tibia, or fibula, have been cut out with a view of promoting the healing of ulcers that seemed otherwise incurable, or getting rid of an obstinate affection of the bone. Many operations for necrosis are also erroneously entitled resections of the shafts of the bones, when they are really only extractions of sequestra; but in a few cases the necrosed shaft has been removed while yet connected to the living bone. Such operations, however, whether undertaken on account of caries or necrosis, too often result in failure. In cases of necrosis of a portion of the thickness of a bone, resection should very rarely be practised—perhaps we might say never, unless for the relief of inflammatory symptoms propagated from the diseased bone to neighbouring organs. Nor, in cases of necrosis of the whole thickness of the shaft, is it usually advisable to operate until the old shaft has separated from the new bone, and the latter has acquired some volume and firmness. No special directions are needed for these operations. The chief point to be attended to is to keep as close to the bone as possible, in order to spare not merely the tendons, vessels, &c., which may lie in relation with the diseased bone, but also the periosteum; so that there may be as good a prospect as possible of the regeneration of the part removed. In spite, however, of what has been said as to the results of subperiosteal resection, I cannot discover any evidence of the restoration of the continuity of a long bone after its interruption by the resection of a piece of its shaft, except in cases of necrosis.* Probably, if the piece were very short, union might occur; but the necessity for the removal of such a piece could hardly ever arise.

T. HOLMES.

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* See Wagner *on Repair after Resection,* New Syd. Soc., 1860, pp. 131-233, and 238-241.

DISEASE OF THE SPINE.

THE spinal column is subject to a morbid process so much more formidable and frequent than others, that it is emphatically called Disease of the Spine. This consists essentially of Caries of certain vertebræ; whence that term is frequently used. From the distortion, caused by loss of substance of some portion of the spine, the name Angular Deformity is also applied. In foreign works, it is called the malady of Pott,—from the first standard description of it given by our countryman.

Caries of the spine is properly included among diseases of the Joints. The morbid action by which the bodies of the vertebræ and the fibro-cartilages are disorganised is identical with that which destroys the joint-structures of the carpus, tarsus, and spongy ends of the long bones. But owing to the spine combining the apparently irreconcilable offices of being a flexible pillar, and the guardian of the spinal cord, various special characters belong to its diseases.

Of Caries. The morbid process thus termed exhibits itself, first, by consuming the portions of bone and fibro-cartilage attacked; secondly, by exciting a discharge of pus. Pathologists concur in regarding the diseased action as the same in bone, that we witness in ulceration of the soft structures. Hence, to show the application of the terms, it would be said that the bodies of the vertebræ were corroded by caries; that the fibro-cartilages were destroyed by ulceration.

A question has often been discussed, whether the disease originate in the hard, or soft textures. But as yet no satisfactory answer has been given. It suffices to know, that when the process has commenced, all the structures yield indiscriminately to its destructive agency. In the child, temporary cartilage enters into the composition of the parts; and we find that osseous, fibrous, fibro-cartilaginous, and cartilaginous tissues are all disintegrated and removed in an apparently identical manner.

An important distinction exists as to the segment of the spine liable to be attacked by caries. The anterior, including the bodies, intervertebral substances, and accessory ligaments, is the special seat of spinal disease. The posterior, consisting of the pedicles, arches, transverse and spinous processes, together with the articulations of the oblique processes, has no similar tendency. It is a remarkable pathological fact, that numerous as are the small joints in the back of the vertebral column, disease in them is scarcely ever witnessed. And when caries has exhausted its destructive agency on the bodies, it seldom or never spreads backward to infect the articulations of the oblique processes. It will presently be seen that the structures of the posterior segment exhibit a disposition to take on a reparative action, antagonistic to the morbid process in front.

When caries selects a part of the spine for destruction, it may either limit itself to one or two bodies, and disorganise them wholly or partially, without much injury to the adjacent bodies; or it may extend along the surfaces of numerous contiguous vertebræ, and corrode a great many, each in a slight degree. In proportion as the ulceration proceeds deeply, a chasm, more or less wide, is formed between the remaining sound portions. The part of the column which has been thus sapped at its foundation falls forward, and Angular Deformity is the consequence. Again, the destruction of the bodies and intervertebral cartilages is accompanied by the formation of Abscesses. Lastly, the spinal cord is subject to be implicated and deprived of its functions, thereby causing Paraplegia. But before proceeding to treat in detail of any of these grave effects, it will be convenient to examine the symptoms of spinal disease, in its incipient stage.

Incipient Stage of Caries of the Spine.

The disease is generally admitted to be one of the class called scrofulous. Yet it is frequently met with in patients who do not otherwise exhibit signs of that diathesis. Its origin is often attributed by the patient or his friends to an accident—one that probably occurred a long time previously. The evidence is seldom satisfactory. Greater importance is due to the unsound condition of the constitution, which would lead what is commonly a slight injury to produce such disproportionate effects.

Caries of the spine may commence at any period of life. Past the middle term it is extremely rare. It is most rife from early childhood to adolescence. It occurs equally in the two sexes.

Angular projection. The symptom which deserves earliest notice is the appearance, at the seat of the caries, of a prominence, in one or more of the spinous processes. The primary cause of the projection, or (according to a common expression of patients) of the "growing out" of the back, is the destruction of a certain portion of the front of the spinal column. The superior part of the pillar falls forward, from having been undermined, and forms an angle with the inferior. The spinous process of the particular vertebra which has had the deepest excavation, will protrude the most, and be the apex of the angle.

In the advanced stage of the complaint, no symptom is more easily detected, or of less doubtful significance, than this prominence of the spinous processes. Owing to long absence of motion in the affected part, the muscles in each trough will have become atrophied. Consequently the ridge will stand out conspicuously, like a keel, with a rugged, serrated edge, the knob of each process being distinctly visible. Laterally, also, the protrusion of the transverse and oblique processes will be distinguishable. But before the angle is decidedly formed, and while the superjacent structures are sound, there are sources of obscurity which sometimes make the diagnosis difficult.

In certain regions of the column the prominence of the spinous processes is discernible at an earlier period than in others. It is shown in the dorsal vertebræ sooner than in the lumbar; and the reason is obvious. In the dorsal region, the spine has a natural incurvation, the convexity of which is backward. Hence the ridge of spinous processes—although each is pointed downward and overlaps the other—is more superficial than elsewhere. When even a small part, therefore, of the substance of one of the bodies is lost, the incurvation forward becomes at once conspicuous. But it is different in regard to the lumbar region. The normal curvature in that part is concave posteriorly; accordingly, although each spinous process is pointed backward, the ridge is in a hollow, and difficult to be felt. Moreover, the bodies and intervertebral cartilages, being of large size, can be excavated to a great depth, without perceptible bending. The consequence is, that caries may exist in the vertebræ of the loins, for a long time, without visible protuberance of the spinous processes. The same observations, with slight modification, apply to the cervical vertebræ. When caries invades the body of one or more of these bones, the effect of the loss of substance is, that the head, by its weight, subsides vertically; and the consequence is, that the space between the occiput and upper part of the chest is so much contracted, that the fingers cannot be inserted to feel the spinous processes and ascertain their condition.

But in reference to the normal incurvations adverted to, we must remember that they are not perfectly established till about the period of puberty. Again, the spine is endowed in early life with such great flexibility, that it bends, with remarkable freedom, throughout its whole length; and if the child be debilitated from any illness, the suppleness of the column will be proportionately increased. Now when the spine is thus incurvated, the ridge of spinous processes may stand out prominently, even where not expected, as in the lumbar region; and the appearance will have a striking resemblance to that in the back of a patient affected with caries of the bodies. A difficulty of diagnosis hence arises. The only means of becoming satisfied that there is an absence of disease, is by observing that no single spinous process projects decidedly further than the rest; and that on laying the child on its belly, and elevating the hips, the convexity of the incurvation is obliterated.

Swelling. Tumefaction is seldom a distinctly marked symptom, rarely amounting to more than a diffused thickening and induration of the structures over the projecting vertebræ. When considerable, it indicates an actively progressing condition of the caries. If absent, and the points and surfaces of the bones are clearly defined to the touch, it proves that the disease has subsided, and ankylosis has probably taken place.

Heat. During the acute stages of caries, increase of temperature may be perceived in the affected vertebræ.

Rigidity of the spine. If the hip-joint be diseased, an early indication is impaired motion; and a similar stiffness characterises the commencement of disease in other articulations. In like manner, when caries invades the bodies of particular vertebræ, one of the first signs is a defect in the natural mobility of the affected bones and those adjoining. For detecting the incipient stage of the disease, this symptom is of great value. Owing to the extreme flexibility of the spine in children, we may not always be able to avail ourselves of it; in patients above that age, however, the symptom never fails. There are various ways by which the rigidity can be manifested. The patient may be made to stoop forward, or lean from side to side; when it will be perceived that the four or five vertebræ where the disease is supposed to exist do not participate in the general flexion, but move together as a united, compact mass. If the Surgeon plant the palm of his hand flatly and broadly over a sound portion of the spinal column, and direct the patient to bend and extend his back alternately, he will be sensible of the several processes separating, or approaching, in reference to each other, in correspondence to the different movements. But if he shift his hand, and place it, in like manner, over the part where the vertebræ are suspected to be carious, he will not have the same sensation as before: the distinct processes will retain their relative distances from each other, whatever may be the general movement. The stiffness and want of resilience may be thus accounted for: as soon as the process of caries is begun in the bodies of the vertebræ, inflammatory action is set up in the adjoining textures: at the focus of the disease, namely, in the anterior segment, the action is of the suppurative type; but in the posterior segment it is adhesive and defensive: accordingly, at the same time that the front of the column is consumed by ulceration, coagulable lymph is deposited in the tissues which connect the vertebræ together posteriorly; and in proportion as that solidifies, the motion between them is arrested.

Pain. This, which in general is the faithful guardian of the textures of the frame, is a fallacious monitor in regard to diseases of the spine. It fails to warn when danger is imminent, and cries out when nothing is to be apprehended. Many are the patients with confirmed angular deformity, who have never kept their bed, on account of pain, for a single day. Again, the Surgeon is continually being consulted concerning others,—almost invariably females,—who have suffered sharp pain, in a particular spot of the column, for months or years; and who, during all that time, may not perhaps have ventured once off their couch, from the impression that such dreadful suffering could proceed only from formidable disease,—yet having all the while every vertebra of their spine perfectly sound.

Nevertheless, in certain cases pain is a leading symptom of caries. It is shown by the patient's inability to sit up. When lying in bed, the act of turning him round will cause great agony. His nights will be sleepless. He will sometimes complain of a sense of constriction about the epigastrium. Attacks of such severe pain do not commonly last long, but they are apt to recur. They indicate accessions of acute morbid action at the seat of disease.

In the more numerous class of cases, in which pain is subordinate or dormant, particular devices are necessary to make it recognisable. While the patient is upright, a shock may be given to the spine by the Surgeon placing his hands on both shoulders, and suddenly depressing them; the jerk will probably cause pain at the affected part. Or the same object may be gained by asking the patient to jump from a low stool upon the floor. Strongly pressing upon, or percussing each spinous process in succession, is another mode of evolving latent pain. The plan of carrying a hot sponge down the spine, in expectation of the warmth rendering the pain more sensible, has not much to recommend it.

Neuralgia of the spine. For diagnosis, it is necessary to advert in this place to the painful affections of the spine, which have just been alluded to, as frequently causing uncalled-for alarm. Among these we do not include pains in the back which arise from rheumatism, dyspepsia, diseases of the kidneys, or of the uterus and ovaries. The affection to which the term 'neuralgia' properly applies, is of the same nature as 'clavus hystericus' in the head. It derives its principal characters from the state of constitution known as the 'hysterical diathesis.' Pains of like kind become settled in various parts of the body, especially the joints. They were designated by Sir B. C. Brodie cases of 'hysterical neuralgia.' When the spine is affected, the patient (who it may be presumed is a female) will complain of a sharp piercing pain fixed in a particular spot, situated, according to her sensation, deeply on one side of certain vertebræ, and occupying a space which may be covered with the point of the finger. All parts of the column seem equally subject to the pain; but it commonly continues, in the same patient, in one place. The physical suffering to which the pain gives rise is undoubtedly great. But its worst effect is, perhaps, that produced on the mind. The patient becomes possessed with a conviction that so much intense pain can be produced only by some frightful ulcer; she forthwith devotes herself to its treatment, as if she had disease of a malignant character, corroding and destroying her spine. She is soon furnished with an invalid bed. Then the chances are in favour of her remaining a prisoner upon her back, not for six months or a twelvemonth, but for several years consecutively.

Numerous facts show that, however acute and persistent these pains may be, they do not proceed from organic lesion. On examination, the patient will be observed to wince, and jerk her spine, every time she is touched,—movements irreconcilable with there being positive disease. It will be further remarked, that although the supposed ulceration must, according to the account of the duration of the pain, have been active for a long period, no deformity has been produced—not even rigidity—in the affected vertebræ.

The writer cannot quote any case of the kind referred to in which the spine has been examined after death, to ascertain the actual condition of the bones. But in analogous cases of neuralgia in other joints, as the knee, he has had opportunities of observing that, even when the pain was so severe that the patients have been prompted to solicit amputation for a remedy, the structures were sound. He witnessed two cases, both under the same Surgeon, in which it was supposed that the severe pain, referred to the knee, was caused by ulceration of the cartilages, and in which it was deemed necessary to remove the limbs. On inspection of the joints, the cartilages and all the other structures were, in both cases, found perfectly healthy.* Hence it may be inferred that the articulations and bones of the spine, affected with similar pains, would also be found, if examined, free from organic disease.

If the nervous pain happen to be accompanied by hysterical paraplegia, a complication not uncommon, the diagnosis will be rendered more difficult. And if the patient should have besides, what is frequent in females, lateral curvature of the spine, a new element of perplexity will be added. The writer had under his care a governess, twenty-two years of age, in whom the various maladies referred to were combined, and who was obliged to sacrifice her situation, owing to the Surgeon of the family pronouncing her case to be one of caries, requiring a long period of rest in the recumbent position. She had a protuberance of the spine on the convex side of the lumbar curve. But that was caused simply by the ordinary rotation of the vertebræ on their long axis which accompanies lateral curvature,—a rotation produced by excessive absorption of the articular processes, from pressure, on the concave side. This projecting part was the seat of severe hysterical pain. She was also unable to walk without support; and then only by dragging the legs. In a few weeks, under treatment by calisthenics, shower-baths, tonics, &c., she perfectly recovered.*

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* The subsequent history of one of these patients was not a little remarkable. Although the stump was a perfectly good one, it soon became the seat of pain, equal to what had been felt in the knee. Thereupon the Surgeon repeated the amputation higher up. Healthy cicatrisation took place; but ere long pain as bad as the first returned in the new stump. The next proceeding was to excise a large portion of the sacro-sciatic nerve. But this operation had no better result than the preceding. Neither Surgeon nor patient, however, lost heart. As there still remained a portion of limb capable of removal, amputation at the hip-joint was performed. The large wound healed favourably. Yet the pain did not depart; it continued in the cicatrix as great as ever, and of the same kind as at first. The young woman was eventually sent to the sea-side. There she became pregnant. Upon her return, it was ascertained that as soon as she felt herself in the family-way, the neuralgia ceased. Having subsequently become the mother of a large family, she has been frequently seen on account of her children; and according to her statement, she has still occasional attacks of the old pain in the stump.

The writer has been informed of a case similar to the above that occurred recently; in which the Surgeon was induced, chiefly by the earnest solicitations of the patient, a woman of hysterical temperament, to amputate her limb for supposed ulceration of the cartilages of the knee-joint. The structures were all found perfectly healthy.

Angular Deformity.

It is easy to understand that, if the substance of one or more bodies of the vertebræ be removed by caries, the super-imposed portion of the column will fall forward, and form an angle with that below. It is not, however, the weight alone which influences the flexion. When a patient is confined strictly to the recumbent position, and pressure is thus removed, the angle nevertheless continues to increase in acuteness; which shows that the action of the abdominal muscles shares in causing the deformity.

As the bodies and fibro-cartilages occupy the mesial line of the body, it follows that, upon their destruction, the pillar will descend and bend in the median plane, without lateral deviation. The only parts at which it is apt to incline to one side are the lumbar and dorso-lumbar regions, where it has greatest latitude of motion. The writer was consulted in the case of a girl of fifteen, supposed to have lateral curvature; proceeding on that view, the medical attendant had previously put her on a course of calisthenic exercises for strengthening the muscles of the back; there was at the junction of the dorsal and lumbar vertebræ, an angular deformity, modified by a decided incurvation to the right side, without any second curve above. The projection posteriorly was recognised to result from caries, by the directness with which the spinous processes stood out, and pressed against the skin. In lateral curvature, owing to the rotation of the vertebræ on their long axis, the spinous processes always point laterally, and are over-lapped by the edge of the longissimus dorsi, so as to be nearly hidden.

But the angular deformity caused by destruction of the bodies of the vertebræ at a particular part does not consist in a simple falling forward of the undermined portion. If an inflexible pillar, like the mast of a ship, were cut through,—to save the vessel from shipwreck,—the part at the base would remain perpendicular, the top would fall over, and an angle more or less acute would be formed. But in the human figure, if the superior part were to project forward, while the inferior was upright, the equilibrium would be destroyed. The patient on attempting to walk would tumble headlong. It is true that when the spine has just recently become bent, the person has difficulty in preserving his balance; but by grasping both knees, and using his arms for supports, he manages to get about. Ere long, however, he succeeds in correcting the inequality in the line of gravity: and that he accomplishes by gradually throwing the whole head and trunk backward. Accordingly, it is always observed that the lower part of the column, instead of being upright, is directed posteriorly in relation to the sacrum, and that the apex of the hump projects considerably backward compared to the hips. At the same time the patient casts his face up, and throws his chest forward, with an apparent air of pride. It results that, as the angular projection posteriorly is combined with two incurvations, one above, and the other below, in contrary directions, the whole spine assumes an appearance, when looked at in profile, not unlike a double bracket (}). And it is of some practical use to be acquainted with this peculiarity of the incurvations. It throws light on the way in which the quack effects a temporary improvement in the figure, after ankylosis has taken place, in cases of angular deformity. By confining the patient on his back, and employing mechanical means to stretch the spine, he succeeds, in the course of time, in straightening those portions of the column which are above and below the seat of disease, and thus bringing them more nearly to a level with the ankylosed vertebræ. Hence the "hump" is rendered less prominent and conspicuous. But as the inclination of the spine at the angle cannot be got rid of, and it is that which deranges the equilibrium, the incurvations are sure to return, and be as bad as before. And, as will be seen presently, the treatment is attended with serious dangers.*

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* See the article HYSTERIA, vol. i. p. 363. Lectures on Local Nervous Affections, by Sir B. C. Brodie. Also a masterly Essay on the moral constitution in females of hysterical diathesis, by Dr. Robert Ferguson, prefixed to the edit. of Dr. Gooch's Works, published by the New Sydenham Society.

When the lumbar vertebræ, or these and the sacrum together, are so extensively destroyed that the column sinks from its very base, the whole body is unavoidably thrown directly forward, and the patient cannot make use of the means described above to recover his equilibrium. Ankylosis, therefore, takes place with the spine at right angles to the pelvis, and the patient is incapable of holding himself upright. Accordingly, if he attempt to walk, he can do so only with his body directed horizontally. He is condemned to adopt the mode of progression of quadrupeds, on all fours, *ventre à terre.*

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* See, in the museum of the Medical College of Middlesex Hospital, a series of casts taken from patients with angular deformity, after treatment by extension.

Thorax. Excavation by caries of parts of the bodies of the dorsal vertebræ, and angular deformity thence produced, cause the whole chest to be included in the distortion. The greater the acuteness of the angle, the more the ribs will be displaced and compressed. Owing to the falling forward of the portion of the spine above the angle, and its carrying the ribs with it, the sternum projects in front, and in some cases is even bent at an obtuse angle; thereby forming, as it were, a counterpoise to the posterior protuberance. The general effect of the changes of conformation is, that the antero-posterior diameter of the cavity is increased, and the vertical decreased. The shortening of the trunk, as a whole, leads to the abdomen being what is termed potbellied.

The viscera, both thoracic and abdominal, have a remarkable property of accommodating their various forms to the new shapes assumed by their respective cavities; and in this adaptation neither their internal structure nor their functions suffer appreciable damage. The lungs, heart, liver, stomach, &c. present deformities of a most striking appearance, corresponding to their mode of being packed together. The œsophagus and trachea are simply shortened. The aorta, following the course of the spine, and giving off its intercostal branches, is bent at the site of the angle.

Caries not unfrequently attacks two distinct parts of the spine, at a distance from each other; either simultaneously, or, more commonly, at different periods. The writer has witnessed several cases of the kind, in which the patients have recovered as in the ordinary course of the disease. In the last, the young patient had just recovered, with moderate deformity, from caries of the dorso-lumbar vertebræ, when he was seized by disease in the cervico-dorsal region, lost the power over his legs, and died in a few months.

Spinal Abscesses.

The importance of the subject of abscesses connected with caries of the vertebræ will be appreciated when it is considered that they are the most frequent causes of death, in this disease. Deformity is an affliction for which the sufferer may be commiserated; paralysis of both lower extremities claims our sympathy; but it is from the effects of large abscesses that patients may be expected to die.

It has been said that caries is a species of ulceration, and that the corrosion of the bone and fibro-cartilage is attended with suppuration. In common ulcers, situated on open surfaces, as the skin or mucous membrane, the pus thus secreted is cast off and lost. But in the ulceration of spinal disease, the matter on the surface is caught by the loose connecting tissue; this becomes thickened and condensed into the walls of a cavity; and eventually a regularly built abscess, with proper pyogenic membrane, is constructed.

We can recognise, in all abscesses, a principle of self-cure. With the act of producing pus there are associated the antagonistic processes—of absorption, and reparative growth. When the termination is by "resolution," the fluid is removed by an action analogous to assimilation; the pus-globules undergo disintegration; their particles mixed with the serum are absorbed by the capillaries; a process of new growth takes place simultaneously, and the cavity of the abscess is filled up. If the cure be by "pointing" and breaking, the proceeding is different. The object is to conduct the pus to the exterior, and throw it out as a foreign body. This end is accomplished by the act of absorption operating with principal activity near the surface; while, at the same time, the process of new growth is carried on effectively at the base of the abscess. By this means a thinning of the structures intervening between the superficial part of the walls of the cavity and the skin takes place; and, *pari passu*, an increase of substance in the underneath structures. When the pus has thus been protruded (in a manner analogous to the growth of a tooth, or escape of necrosed bone), the skin at last breaks, and the fluid is discharged; or if the skin cannot be reached, and the trachea, portion of bowel, bladder, or other outlet of the body, be in the way, the abscess will burst into either of them. After the pus is evacuated, the process of reparation continues; and the cavity is eventually filled up by a growth from the bottom, just as an open wound is healed by granulation.

If we apply these principles to the elucidation of abscesses formed in consequence of caries of the spine, they will assist in explaining the different courses pursued by them: how, in some cases, they may be removed by resolution; and, in others, by discharging their contents, at a distance, outwardly.

It has been already stated (supra, p. 832) that when caries attacks the spine, one segment alone is affected by the morbid action; that the bodies of the vertebræ and fibro-cartilages are the special seat of the disease; and that the posterior segment is exempt. It follows from this distinction that the inflammatory action, which attends caries, will assume the "suppurative" type, leading to the formation of abscess, in front, or upon the bodies and fibro-cartilages; but that it will be of the "adhesive" or reparative type, in the posterior segment. It is obvious, therefore, that it will depend on which of these two forms of inflammation predominates, as to whether, in any given case, the abscess will be large and burst externally, or be circumscribed in its growth, and disappear by resolution.

It will be preferable to consider, first, those cases in which the patients have recovered, without the abscess having advanced so far as to be recognised, and in which the only memorial of the disease has been the deformity; secondly, those in which suppuration has obtained the mastery, and the matter of the abscess has been evacuated through the skin.

Termination of abscess in resolution. Of patients deformed from caries, a large proportion will be found to have passed through all grades of the disease, to have had paraplegia, and to have been restored to health and activity, without signs of any abscess in connexion with the vertebræ having exhibited themselves. There are others who, in like circumstances, have continued for months, perhaps years, free from any external abscess; but, at last, one has been discovered; at first concealed and difficult of detection, but latterly bursting forth conspicuously. Again, in many cases, the abscess will have appeared outwardly at an early period of the deformity, discharged, and brought the patient to a speedy end. When we meet, therefore, with a case in which there has been no manifestation of abscess, we are not justified in concluding that one has not existed. The inference ought rather to be, that an abscess has really been formed; but that it has been kept in subjection, and prevented from developing to a large size, by the processes of resolution, which have eventually led to its perfect removal.

It is important to observe how this process of absorption of the matter contained in an abscess is favoured by the inflammation affecting the posterior segment of the column, being of the adhesive type. As mentioned before (supra, p. 835), the effect of the deposit of coagulable lymph in the connecting structures behind, is to consolidate the vertebræ, and thereby impede, or stop, motion between them. The result is, therefore, similar to what is produced by the application of a splint to a diseased joint, or the throwing out of callus in a fractured bone. The surfaces are kept at rest, and protected from the injury to which attrition and jarrings are apt to give rise. Consequently, if there be a disposition in the morbid action to subside, it is encouraged. It may, accordingly, be anticipated that the production of new pus in the abscess will be arrested, and that absorption of the old will take place. The walls will, in that manner, become contracted and thickened, and the cavity eventually be filled up and obliterated.

Ankylosis. But an additional process will be carried on simultaneously with those just mentioned; namely, union of the affected vertebræ by bone, or "ankylosis." When reparative action takes place in bone, whether in the case of fracture or disease, the natural product is ossific matter. Consequently, in proportion as the abscess diminishes by absorption, the affected vertebræ will become knit and fused into one another, as in union of a broken femur.

Spurious ankylosis. In a communication made some years ago by the writer to the Pathological Society, he brought forward certain facts to show that ankylosis commenced in, and in many cases was restricted to, the posterior segment. He exhibited a series of five specimens of the spine deformed from caries, in which the bones had become consolidated and immovable; and in all of them a continuous line of ossific union could be traced along the whole posterior surface, between the laminæ, and between the articular surfaces of the oblique processes; while on the fore-part, open spaces, of various degrees of width, intervened between the rugged surfaces of the corroded bodies. It appeared that, owing to the solidification of the spine posteriorly, the column had been rendered incapable of bending, and forming an angle sufficiently acute for the confronting ends of the bodies to coalesce, and come into proper coaptation, for union between them to take place.*

It will thus be perceived that, in some cases, when the vertebræ have become fixed, and apparently soundly united by bone, the junction has been only partial; that the posterior segment alone has been connected by ossific matter. As for the bodies, they are held together by the remains of the walls of the abscess, which adhere closely to their surfaces, and act as ligaments. An amorphous, friable substance, not unlike putty, and which may be the débris of the pus formerly contained in the cavity, will fill the interstices of the partially consumed bodies.

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* See *Path. Soc. Trans.*, Session 1847-48, p. 328.

True ankylosis. Opposed to this defective union is that in which the vertebræ are joined by bony substance through their whole thickness. It will be found that notwithstanding the whole body of one, or two of the principally affected vertebræ, together with portions, of greater or less size, of the bodies of the adjoining bones, and the intervertebral cartilages corresponding to them, have been destroyed, and altogether disappeared, true solid ankylosis may nevertheless take place. The surfaces will have coalesced, owing to the spine having become bent at a very acute angle; and there will be a union so close, that several vertebræ will be fused into one another, and the distinction between them effaced. It will also be observed, that every trace of the walls of the abscess, which must have previously existed, will have been removed by absorption.

The distinction between these two modes of union, it is obvious, is of much practical importance. Owing to the insecurity of the junction, in the "spurious" form, there will be continual danger, either of the spinal cord being seriously damaged,* or of the imperfectly extinguished disease being lighted up again, from casual violence to the spine, inflicted in the ordinary occupations of an active life.

If it be now asked, how we may discriminate, in any particular case, between ankylosis that is true, or spurious, it must be admitted that our answer can only be conjectural. In both cases, there may be an absence of any outward appearance of abscess; and the spine, so far as the closest examination can show, may be perfectly rigid, as if the consolidation were complete. The only guide, it appears, is

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* A young woman had caries of the upper dorsal and lower cervical vertebræ, from which she recovered, so as to resume her employment. The angular deformity being considerable, she applied to a quack, who undertook to restore the figure to its natural shape. The chief part of the treatment consisted in forcibly stretching the neck by mechanical means. When increasing the power, one day, there was an audible snap, with sudden pain; and the patient was immediately found to be paralysed throughout all the body below the neck. She died shortly afterwards; and on a post-mortem examination, it was discovered that the walls of a nearly obliterated abscess in front of the bodies of the carious vertebræ, had been extensively torn from their connexions with the bones. The medulla was diffluent. The inference drawn was, hat although the affected vertebræ had been firmly united by bone in their posterior segment, there was an absence of ossific union in the bodies; that the mechanical force employed had been sufficiently great to rupture the ligamentous structure constituted of the remains of tho abscess-wall, which was the only bond of union between the bodies; and that by the sudden elongation thus produced the spinal cord had been lacerated.

the acuteness of the angular projection; and, it may be added, information regarding the period of life at which the disease subsided. The two principal obstacles to the surfaces of the upper and lower ends of the bodies coming into coaptation, preliminary to their union, are, first, the natural inflexibility of the spine; secondly, premature union of the posterior segment of the vertebræ. Now it may be inferred that in early childhood, when the spine is most flexible, there will be greater probability of a cavernous space in the bodies of the vertebræ being effectually closed by the falling together of the surfaces, and of ossific union supervening, than at a later period of life, when the spine loses its flexibility. It may, therefore, be anticipated that the coalescence and ankylosis in front will have taken place, before solidification can have been accomplished in the posterior part, to impede the flexion, in a patient under ten or twelve years of age; whereas in a grown-up person, the normal rigidity will keep the surfaces apart. It coincides with this view that spinal disease, although a frequent malady of children, is much more rarely fatal in them than in adults; a distinction which cannot be accounted for, simply from the greater power, in the former, of repairing organic lesion. Accordingly, as the Surgeon has no means of calculating in any particular case, how large and deep the hollow in the spine may be, and is aware that, to obtain perfect union between the opposing surfaces, the spine must necessarily be bent, even at an acute angle, he abstains from employing measures that might counteract the flexion. On the contrary, he looks complacently at the gradually increasing sharpness of the angular prominence; satisfied that, however we may regret the disfigurement, it is not an unmitigated evil, and is unavoidable. The friends of the patient, ignorant of the process of cure, or of the formidable consequences to be apprehended from the failure of perfect ankylosis, are nevertheless apt to express dissatisfaction at the apparent neglect.

Psoas Abscess.

We now arrive at the consideration of those spinal abscesses which, instead of yielding to the processes of absorption, enlarge, overstep their original boundaries, and travel great distances, so as finally to evacuate their contents externally. There are certain varieties in the course which these large abscesses take. The most frequent direction is in the line of the psoas muscle. Another common direction is backwardly in the lumbar region. Distinct names have been given to the abscesses according to the route they follow.

It is proposed to adopt the "psoas abscess" as the typical example; and after having pointed out its principal characters, to treat briefly of the varieties.

The term, psoas abscess, was first applied under a mistaken notion that the collection of matter which takes the course of the muscle, actually originated, independently of disease of the spine, in its interior. But it is now generally admitted that the source of the abscess may always be traced to caries in the bodies of one or more vertebræ. And it is frequently found that, while the collection is of large dimensions, the portion of spine diseased is small, and apt to be overlooked.* Again, the origin of the abscess is not confined to vertebræ with which the muscle is in relation: there is no part of the spine, from the upper dorsal downward, whence it may not start. And in its descent it does not stop where the muscle ceases; it generally extends upon the thigh, and may burrow to the very knee.

It will be convenient, in describing psoas abscess, to suppose a case in which the diseased vertebræ are situated somewhere in the dorsal region.

It might be conceived that, when a collection of matter was thus gathered behind the posterior mediastinum, there would be danger of its compressing the trachea or œsophagus, and thereby causing difficulty of breathing or of swallowing. But effects of that kind are rarely observed; and the reason is obvious. At the same time that the abscess is formed, the spine bends forward at an angle; accordingly all the structures in front become relaxed, and yield readily to the accumulated fluid. It is the same flexion which determines the pus in the abscess to descend; for not only are the tissues on the fore part loosened, but the upper part of the spine, as it falls down, acts in pushing the contents downward. Moreover the walls of the chest behind are an impenetrable barrier against the pus travelling backward.†

In certain cases the abscess, as soon as it begins to enlarge downwardly, bifurcates; and one collection of pus travels along the bodies of the vertebræ on one side, while another keeps pace with it on the opposite. Both sometimes reach the thigh simultaneously. It is more common, however, for one alone to descend.

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* See Brodie *on Diseases of the Joints*, ed. 1850, p. 336.

† The writer can recollect only one case in which the abscess pointed and broke posteriorly between the ribs adjoining the angular deformity. Bubbles of air floated on the pus at each of the two orifices; and these were drawn inwardly at each inspiration, but propelled outwardly at each expiration.

Perforation of the diaphragm. The walls of an abscess formed in the dorsal region are covered anteriorly by the parietal pleura; and as they burrow beneath it to the convex floor of the thorax, they encounter the diaphragm. This obstacle to its progress the abscess overcomes by a vital, not mechanical, act. The first step in the process consists in the walls adhering firmly to the surface of the diaphragm; the next, in an opening being made by absorption both through the abscess and muscular septum. By such means the pus gains access to the abdominal region behind the parietal peritonæum; and it is obvious that, owing to the union established between the abscess and septum before the perforation is effected, all danger of extravasation of the fluid during the passage is avoided.

The point at which the opening in the diaphragm is made, is near the situation of the ligamentum arcuatum. It is also to be observed, that from that ligament, and the sides of the neighbouring vertebræ, the psoas muscle arises by distinct fasciculi. It follows from this juxtaposition that, according as the abscess protrudes among the parts immediately below the diaphragm, its walls penetrate between the distinct heads of the psoas muscle, and to a certain degree split them asunder. In this manner an expansion of the muscle is produced by the successive additions of pus, and an amalgamation takes place between its fibres and the walls of the abscess. Hence the psoas muscle gradually becomes hollowed out in the centre, and dilated in its sides, till converted into a bag of pus. Here it may be briefly noticed that, after the perforation of the diaphragm, the most depending part of the abscess, instead of burrowing along the psoas, may be deflected backwardly, and work a passage through the abdominal parietes in the direction of the loins. The collection of pus thus presenting itself superficially, will obtain the name "lumbar" abscess, and will be treated of distinctly hereafter.

The dilatation to which the psoas muscle is subjected by the gradually increasing accumulation of matter, varies according to the density of the cellular sheath which invests it. That envelope is formed by the splitting of the iliac fascia into two layers; whereof one passes in front, and the other behind. The former layer, as it turns over the belly of the muscle to line its inside, acquires great strength, and is united very firmly to the edge of the brim of the true pelvis. Outwardly, on the contrary, the sheath is weak. Hence an effectual resistance is presented to the enlargement of the abscess inwardly; but a similar opposition is not offered to it on the outside. It accordingly follows, that in proportion as the pus increases in quantity, it tends to burst forth under the iliac fascia, in the direction of the crest of the ilium. By that ridge of bone exteriorly, and the prominent united belly of the psoas and iliacus internus muscles internally, the lowest or most depending part of the abscess is guided in a groove to the level of Poupart's ligament.

Abscess while in the iliac region. During this part of its course, namely, while the abscess is situated on the centre of the ilium within the pelvis, it is important to know that its presence can be recognised, even before it has attained a large size. The examination is to be conducted by relaxing the abdominal muscles, and directing the fingers against the iliac region. By carrying them over the inner edge of the crest of the ilium, and thrusting them deeply and inwardly onward, a hard, round, well-defined swelling, of an elongated form, and occupying the site of the psoas and iliacus internus muscles, may be felt and surmounted by their points. If traced downward, the swelling will be found abutting against the abdominal parietes above Poupart's ligament. Percussion will assist in confirming the diagnosis.

When an abscess has reached the iliac region, it is not uncommon for it to be arrested in its progress, and to be developed there to a large size; so as to form a distinct prominent swelling, which may either burst, or terminate in resolution.

Passage under Poupart's ligament. Psoas abscess exhibits great constancy in the point of its emergence from the interior of the abdominal walls. That part is a narrow space under Poupart's ligament, between the united bellies of the psoas and iliacus internus muscles and the inferior anterior spinous process of the ilium. Before the transit is commenced, there is commonly a considerable amount of general swelling in the inguinal region. It has been seen that in the course of perforating the diaphragm, adhesion took place, as a preliminary step, between the abscess and the part to be pierced; so it is in the passage beneath Poupart's ligament: the walls of the abscess are united to the abdominal parietes, absorption succeeds, and an opening is thus made for the pus to escape upon the groin. When the most depending part of the collection protrudes, an immediate thickening and condensation of the connecting tissues in the neighbourhood takes place, to form new and strong walls for containing the pus.*

Descent on thigh. When a psoas abscess has emerged on the groin, below the outer third of Poupart's ligament, it may either enlarge there, or, before increasing much in size, descend on the thigh. In the commencement of its course, it abuts against the origins of the sartorius and tensor vaginæ femoris; these commonly arrest its progress outwardly, and incline it inwardly. Hence the most frequent direction is obliquely across the thigh, in the line of the sartorius muscle. But the course downward is subject to variety; sometimes the abscess turns abruptly inward, at the groin; occasionally outward: and cases are met with where the collection divides, one part passing straight down, and another quite to the outside.

"Neck" of the abscess. On the analogy of hernia, the part of the cavity situated between the opening in the groin under Poupart's ligament, and the expansion on the thigh, may be termed the "neck." This portion is subject to considerable variation in its width, in different cases. Directly after the descent of an abscess, especially of a rapidly enlarging one, it may be capacious and easily recognised. But it has a remarkable disposition to contract; and that narrowing often takes place, within a short time, so effectually that all traces of the communication will be lost. It appears as if the pus originally pent up in the parent abscess, having burst through the chief barriers to its progress, the diaphragm, and abdominal parietes, had found free scope to flow into the comparatively loose and yielding structures of the thigh; and that the walls, being relieved of their former tension, had collapsed and become contracted. It is obvious that the condition of this intermediate channel will have a decided influence, as feeder of the lower compartment of the abscess, on the rate of its

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* In his work *on Diseases of the Joints* (p. 267), Sir B. C. Brodie refers to cases in which part of the pus of a psoas abscess had got access, in its passage through the abdominal walls, to the spermatic canal, and appeared superficially beyond the external ring, like an inguinal hernia. The writer witnessed one case of a similar kind, in which the tumour reached the upper part of the scrotum, and was associated with a mere general swelling above Poupart's ligament. The lumbar vertebræ proved to be diseased, and the swelling a psoas abscess, from the effects of which the patient eventually died. But owing to the absence of pain or angular deformity in the loins, the nature of the case had at first been mistaken; and the tumour was supposed to be a rupture. The rigidity of the spine at the affected part was the chief diagnostic symptom to show the existence of caries.

enlargement; facilitating the growth if capacious, and retarding it if constricted. Again, when the neck is so greatly reduced in dimensions as to be hid from observation, it leads to the expanded part in the thigh appearing to be an insulated and distinct abscess. And so deceptive is this character, that the Surgeon is liable to mistake the seemingly circumscribed swelling for a collection of pus formed directly in the part—as a chronic abscess, or suppuration connected with diseased femur—and to neglect looking to the spine for its source. When he compresses it with both hands, for the purpose of expelling the contents back along the spine, he may find that the canal is too small for the fluid to pass, or even for it to be brought into view, by distension. But in other cases, the swelling will diminish, if it and the limb be firmly bandaged; and it will recover its former size by gravitation, upon the roller being removed.

Evacuation of a psoas abscess. When an abscess extends from near the middle of the spine, a considerable distance down the thigh, and the walls are at one part in contact with carious bone, termination by resolution can scarcely be expected. Experience proves that if such mode of cure is ever met with, the cases are about the rarest in Surgery. It appears inevitable that the pus must be discharged. And that may be effected either by the natural process of acumination and bursting; or by the interference of the Surgeon.

It has been already said that there is great variety in the rapidity with which psoas abscess, situated in the thigh, enlarges. In some cases the increase is so distinctly marked that a change will be perceived almost daily; in others, so slow that it will be difficult to discern any difference even in weeks. It will depend, therefore, in any particular case, upon the rate of growth of the abscess, as to the period when it will be mature for giving vent to the matter.

When the Surgeon observes a large gathering of pus advancing and progressively undermining new structures, he is prompted to endeavour to limit the mischief by letting out the fluid. Accordingly, it is the common practice, when obvious that the ordinary local applications employed for subduing inflammation and promoting absorption have been inefficacious, to puncture and evacuate the matter. For an account of the different modes in which this operation may be performed, the reader is referred to the article ABSCESS.*

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* Vol. i. p. 162.

After the abscess has been emptied, it is usual to attempt to procure immediate union of the wound by bringing the lips together with adhesive strapping. It is hoped that, by closing the orifice when the walls are thus contracted, the process of absorption may be carried on with such increased activity, that it will prevent reaccumulation of the pus, and lead to the obliteration of the cavity. But disappointment almost invariably awaits us. It is found that, ere a few days have passed, the swelling has returned; and it is necessary to repeat the puncture. The same thing will occur many times; and at length the wound last made will refuse to unite. The result eventually is, that an orifice is established for the constant discharge of pus from the abscess. Experience of these numerous, almost constant, failures of the attempt to disperse such large-sized abscesses, connected with diseased vertebræ, by frequent puncture and closure of the wound, has induced other Surgeons to relinquish the plan; and, by trusting more fully in nature's proceedings, to let the pus gradually discharge itself by pointing and ulceration of the skin.

Consecutive fever. But this question of the local management of psoas abscess, whether of the acute or chronic type, cannot be discussed apart from that of the constitutional disturbance which they are prone to produce, whenever a breach is made in their walls. Nothing is more striking than the contrast in the condition of a patient who has long carried a large collection of pus in his thigh, without visible injury to his health, and his state when that abscess has either burst of its own accord or been emptied by the trocar. The time varies at which the consecutive fever may be fully established. Sometimes one or two days only elapse; at others, a week, or fortnight. But the patient seldom escapes altogether. He is seized with a fever, in which high action prevails for a short time, but which early leads to dangerous depression. At the commencement he has thirst, furred tongue, headache, cold chills, rapid feeble pulse, hot skin, want of appetite; followed soon by profuse perspirations and diarrhœa; then succeed œdema of the legs, and extensive bed-sores. It is in these cases, as in abscesses from diseased hip, &c., that we so frequently find the liver enlarged to immense dimensions; and when death has carried the patient off, that organ is seen converted into a fatty or waxy structure, or one which combines these two morbid conditions.

A satisfactory explanation has not hitherto been given how the formidable results just described should follow the evacuation of a psoas abscess, or other large collection of pus. The theory generally adopted is to the effect that, when a breach is made in the walls of an abscess, atmospheric air gets admittance into the interior; that a chemical change takes place in the pus from the admixture; that the fluid is vitiated by the change; that the pus thus rendered unhealthy is absorbed; and that the peculiar fever which is so commonly fatal arises from the poisoned condition of the blood. But many reasons might be urged against that view. Suffice it to say that, in the case of empyema accompanied with pneumo-thorax, the air, escaped from the lung, is elaborately stirred up, or churned in the cavity of the pleura, by the motions of respiration, with the pus; and that yet, when the fluid is absorbed, we have no symptoms of poisoning of the blood, or of hectic fever.

It is an interesting fact connected with this question, that immediately after the evacuation of a large abscess, its internal lining membrane begins to secrete pus more copiously than before. For example, an abscess may have remained stationary, perhaps, for weeks, showing that it could not have received additions of matter for that time; but it will be found that, about the next day after it has been opened, a quantity of pus, equal to what had been discharged at first, will be thrown out; and that the same amount will be formed every twenty-four hours for many consecutive days; till, as the patient gets weaker, it will gradually decrease. Now it is evident that this increased activity in the secretion must be the consequence of an accession of inflammation in the pyogenic membrane of the abscess.

How has that inflammatory action been excited? If we contrast the structure of the walls of an abscess with that of the coats of any of the hollow viscera, an answer will perhaps be found. The stomach, urinary bladder, &c., are designed to expand as their contents increase, and to contract in expelling them. A parallel may, therefore, be drawn between them and an abscess. In the natural cavities, it is known that the mucous membrane, analogous to the pyogenic, is attached by loose connecting tissue to the muscular coat, analogous to the basement of the abscess; and that the object of this intervening tissue is to allow the mucous coat to be either distended or corrugated, according as the viscus is full or empty, without injury to its blood-vessels, nerves, or own structure. The abscess, however, has no cellular coat. The pyogenic membrane and basement are solidly united together. No provision, therefore, is made for that delicate, soft, thin, and vascular coat being thrown into folds during contraction, or gently expanded during dilatation, irrespectively of the basement. However greatly opposed to each other in point of fineness of structure, the two parts move compactly and equally. Again, whereas the stomach and bladder are free to expand or contract in a common cavity, the abdomen, the abscess is adherent all round to unyielding adjacent structures, which restrain its movements irregularly. When these circumstances, all so unfavourable for the alternate dilatation and closing of the walls of the abscess, are considered, it can be understood that both from the act of contraction, when the pus is evacuated, and from that of expansion, when the fluid accumulates again, they will be subject to much internal injury,—that in the one case, the pyogenic membrane will be compressed, crushed, bent, and cracked; and in the other, overstretched and torn. Such extensive damage, it is reasonable to suppose, will set up inflammatory action; from which constitutional disturbance of the most formidable kind may well be apprehended.

Varieties. Lumbar abscess. When a spinal abscess presents in the loins, it gets its name, without regard to the situation of the carious vertebræ where it commenced, from the locality at which it becomes superficial. It has been stated above (p. 847), that when a collection of matter descending from some of the dorsal vertebræ had perforated the diaphragm, and was no longer restrained by the ribs from passing posteriorly, it might penetrate backward and appear upon the loins, instead of burrowing into the psoas muscle. It has the same choice if the disease be in the lumbar vertebræ. The pus makes its way directly to the back, between the last rib and crest of the ilium, chiefly by perforating the quadratus lumborum muscle. The orifice thus made is of small size compared with the dimensions of the swelling when it reaches the surface. Before the collection arrives at the back, it meets with opposition from various dense fasciæ and tendinous aponeuroses, which deflect it in different directions, and cause it to assume a broad, rounded appearance, with slight elevation. The boundaries of the abscess usually are,—the lowest rib superiorly, the crest of the ilium inferiorly, the sacro-lumbalis internally, and the edge of the external abdominal oblique externally. In all essential characters, a lumbar may be regarded as a modified kind of psoas abscess; and it is not rare to find both on the same side in the same patient. Sometimes a portion of the proper wall of a lumbar abscess gives way close upon the outer edge of the crest of the ilium, so as to allow a portion of its contents to descend over the pelvis, beneath the fascia of the glutæus medius, causing a diffuse swelling, difficult of recognition. The progress of the abscess toward pointing and bursting is commonly slow. When the matter has been discharged, the walls collapse; and owing to the relatively small size of the deep orifice, a narrow, direct channel through the abdominal parietes, communicating with the cavity of the abscess in the interior, takes the place of the former external abscess. That sinus is not prone to close up and heal, but generally continues to discharge pus, which varies in quantity according to the condition of the disease within. The patient is subject to the same constitutional fever after the evacuation of the contents as in psoas abscess.

Abscess in the cervical region. Disease affecting the two uppermost vertebræ of the neck, the atlas and axis, has certain special characters; and it will be treated of separately. If the bodies of any of the other vertebræ be attacked by caries, the abscess will form, as elsewhere, in front. It might be thought that a collection of pus in that situation would cause obstruction to the breathing, by compressing the trachea; or difficulty of swallowing, from pressure on the œsophagus. But owing to the spine bending forward, both these tubes have room to yield, and escape before the swelling; and, consequently, neither function is disturbed. Moreover, after the abscess has advanced a short distance in front, it changes its direction; expanding laterally, at first, and then posteriorly. When the walls, in travelling obliquely backward, encounter the cervical plexus of nerves, the patient may be found complaining of pain or weakness in the upper extremity, while all other parts of the body are free from such symptoms.

Abscesses which discharge their contents by the lungs, intestines, &c. The writer was consulted in the case of a boy affected with angular deformity, the apex being formed by the spinous processes of the fourth and fifth dorsal vertebræ. Five years before, when the deformity commenced, he had been confined to bed; but he had recovered, so as to be fit for any active employment. The object of the consultation was to ascertain whether any thing could be done to improve the figure. In the interview, he showed four pieces of bone, which he had coughed up together with a large quantity of matter, when his illness was at the worst. They were of an irregular cube shape, with rugged surfaces, and the sides measured from three to four lines; their general structure was cancellated, and traces of cortical substance were here and there detected. In short they seemed unquestionably portions of the bodies of vertebræ which had been in a state of caries. It appeared as if these fragments had lain loosely in an abscess connected with the diseased portion of spine; that the walls had become adherent to the lungs; that by ulceration the pus had penetrated into the substance of the lung, and found an exit by one of the bronchi; and that, as the matter flowed from the abscess into the bronchial tubes, the portions of bone had been washed out and expectorated.

The following is the brief notice of a case in which a psoas abscess communicated with a fold of intestine; and in which, not only did the matter of the abscess flow into the bowel, but the contents of the bowel passed into the abscess. The patient was a girl, thirteen years of age, who had acute angular deformity in the centre of the dorsal region, and a psoas abscess of several months duration, on the left side. The external orifice of the abscess was near the knee, being on the inner condyle of the femur. During the writer's visit, the patient picked out with her fingers, from the opening, the skins of one or two peas, and a portion of undigested stalk of greens, which she had been lately eating.

The last case is one in which a thoracic spinal abscess, felt in the iliac region, above Poupart's ligament, discharged its contents into the urinary bladder. The patient, an under-gardener, twenty-four years of age, had angular deformity, the most prominent part of which was at the seventh dorsal vertebra; but he could not tell at what period it commenced. He had reluctantly left work to become a patient, as he alleged that the distortion did not incommode him. On examination, however, an abscess of considerable size was discovered in the iliac region, along the course of the psoas muscle. After submitting to treatment for two months, without perceptible change, he left the hospital. Six months subsequently, he returned, having worked at the spade during great part of the interval. He stated that, a week before, after slight embarrassment in micturition, he had suddenly begun to pass, instead of urine, or in combination with it, large quantities of a yellow creamy matter. This he had continued to do; but the proportion of the urine to the matter had gradually increased. While resident in the hospital, the quantity of pus at each making was about a third of what the bladder commonly holds. On careful examination, no traces of the psoas abscess, which had been often felt before, could be discovered. In a fortnight he left for the country, and was not heard of afterwards.

In the above cases, the process by which the large abscesses, wandering in search of an outlet, had emptied themselves through the windpipe, intestines, and bladder, was the same operation that is performed when an abscess, or cyst containing hydatids, in the liver, is evacuated through the lungs or bowels; or when a gall-stone, too large to pass the duct, is expelled. It is similar, indeed, to the process already described by which a psoas abscess, in its descent from the dorsal region, perforates the diaphragm and the abdominal parietes before reaching the thigh. Firm agglutination by adhesive lymph is first effected between the surface of the abscess and that of the viscus about to be penetrated; that is followed by absorption of a certain portion, within the limits of the adhering surfaces, of the combined walls: an opening is thus formed from the abscess into the new channel; and, owing to the surrounding adhesion, the pus can be discharged through the common orifice without risk of any escape into the serous cavity.

Diagnosis of Spinal Abscess. One general source of difficulty in distinguishing abscesses connected with caries of the vertebræ from swellings of different kinds resembling them, is the fact that the former may exist, and even attain a large size, at a remote distance from the spine, while the disease is so limited in extent as not to cause deformity, except, perhaps, of very doubtful appearance. Were angular deformity always a distinct accompaniment of abscesses in the region of the spine, diagnosis would be comparatively easy.

When a psoas abscess has descended to the thigh, and from the channel of communication between it and the intra-abdominal part contracting and blending with the adjacent structures it has become apparently circumscribed and insulated, there will be difficulty in distinguishing it from a local abscess, unless the proofs of disease in the spine be distinct (see p. 850).

If an abscess originate from caries in the lowest lumbar vertebræ, involving, it may be, the sacrum, it is prone to extend laterally, and rise above the level of the crest of the ilium. When that takes place on the right side, the swelling greatly resembles a cæcal abscess; and the obscurity is increased owing to the indistinctness of angular deformity in caries when situated so low in the spine. The test of disease in the vertebræ most to be relied on, in such a case, is the degree of rigidity at the base of the column.

Should an abscess arising in the part just described, instead of coming to the front of the iliac region, enlarge posteriorly, it may descend on the nates, and break in one or two places near the hip, so as to embarrass the motions of that joint. The case is therefore apt to be looked on as one of morbus coxæ. The writer lately saw a boy, twelve years of age, the son of a medical friend, whose case had thus been mistaken. The principal cause of deception was the indistinctness of the angular deformity at the junction of the spine with the pelvis; and the rigidity of the part, although a strikingly-marked symptom, had been overlooked.

It may not be common to confound aortic aneurism with abscess from diseased spine. Yet when a tumour of that kind protrudes on the back, by the side of the column, especially if one of the spinous processes at the part be prominent, it may assume the appearance of a collection of pus connected with carious vertebræ. The writer was consulted by his colleague, Dr. M. Crawford, in the case of a man who had a tumour, in the dorso-lumbar region of the left side, corresponding to the above description. From observing that, combined with the swelling, there was not only immobility of the affected part of the spine, but distinct protuberance of a spinous process, he concluded that the case was one of caries and accompanying abscess. But the post-mortem examination revealed an aneurismal tumour growing from the aorta, as it passed through the diaphragm. The vertebræ had not suffered from their contiguity to the tumour; and the column was normally straight; but upon inspecting the spine posteriorly, it was found that the spinous process and laminæ, forming the back part of the arch of the eleventh dorsal vertebra, was a separate piece from the rest; and that, at the roots of the transverse and oblique processes, it was connected with the pedicles by joint-structure; so that slight motion between them could be perceived. There was also a general prominence and enlargement of the back of the vertebra, compared with the adjoining bones. The condition did not seem the result of injury, and was considered to be a congenital malformation.*

If an encephaloid tumour protrude backward from the side of the spine, or more in front in connexion with the pelvis, it will be liable to be mistaken for a lumbar or psoas abscess. Every experienced Surgeon is aware of the difficulty that sometimes exists, in other regions where abscesses are less common, of distinguishing deeply-seated collections of pus from cancerous growths. If the malignant disease have previously converted some of the vertebræ into its own structure, leading them to be bent as if from caries, the uncertainty of diagnosis will be increased. In a case lately attended by the writer, the obscurity arose from the spine being incurvated, almost into an angle, from lateral distortion, in the immediate neighbourhood of the encephaloid growth. Some lobes of the tumour resembled the acumination of an abscess so greatly, that more than one Surgeon, consulted on the case, had been deceived, until convinced by the exploring needle.

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* See a drawing and description of a similarly malformed vertebra, from a dissecting-room subject, in Sir C. Bell's *Lectures on Injuries of the Spine and of the Thigh-bone*, plate iii. figs. 5, 6.

Inclusion of the Spinal Cord in the Disease.

When we consider the delicacy of structure and constitution of the medulla spinalis, and its contiguity to the centre of so destructive a morbid action as caries, we may be surprised that its functions are not lost in a greater number of cases than experience shows to be the fact. Yet, as the Surgeon has no means of prognosticating, in any particular patient, whether it will escape, or be affected, he is kept in constant apprehension.

Two circumstances may be mentioned which conduce to save the cord from injury. First, in proportion as the spine falls forward, and forms an angle at the seat of disease, the abscess is propelled to the front, and the chasm between the bodies is closed behind, so as to prevent the pus from having access to the vertebral canal. Secondly, it is within the posterior segment of the spine that the cord is contained; and it has been formerly shown that, while the anterior segment, composed of the bodies, is the special seat of caries, the posterior is exempt from disease, or has only reparative action carried on within it.

Before discussing the morbid process by which the cord is deprived of its functions, it may be interesting to attend shortly to certain changes of structure which it undergoes, in the deformity consequent on the disease, without their impairment. The changes referred to are those which occur in correspondence with the flexion of the vertebral canal, as the column itself becomes bent. When the bodies of the vertebræ have been largely excavated, and the surfaces have afterwards coalesced and united, with the formation of an acute angle, a very considerable diminution in the area of the vertebral canal, especially in its long axis, is an inevitable result. That alteration of capacity, as well as of figure, implies that, to be accommodated to its newly allotted space, the spinal cord must have undergone important interstitial changes throughout its whole substance. And these modifications, both in size and form, will be wrought to an unequal extent in the various columns and beds of cineritious matter of which the cord consists. A similar accommodation is witnessed in cases of lateral distortion of the spine, where the vertebral column, and consequently the canal and spinal cord, are sometimes incurvated and contorted to an extreme degree. Now the most remarkable circumstance is, that notwithstanding these extensive material changes, the medulla continues to perform its functions perfectly. The explanation is founded on its being a law in the pathology of the nervous system, that alterations both of dimensions and form in the brain and spinal cord can be effected to an extraordinary extent, without interruption to their functions, on condition that they are made slowly and gradually, by normal, as distinct from morbid processes. The examples commonly adduced as illustrations of the law are cases of tumours of great magnitude, but of slow growth, which sometimes form within the skull, and by their encroachment cause the disappearance of large portions of the substance of the brain, while the patient retains his powers and faculties entire.

Disorganisation of the Cord.—Paraplegia. From what has just been stated, it will be perceived that the change of structure in the cord, which causes paralysis of the lower extremities, is not the mere alteration of its figure or size which the angular deformity produces. It consists in a conversion of a portion of its substance into a new morbid tissue. A certain part of the organ, adjacent to the seat of caries, undergoes a process of breaking-down of its texture; the most conspicuous effect of which is a softening, approaching to liquefaction, of its columns and gray matter. If the diseased part be tapped with the finger, it will readily yield to the slightest pressure; if a stream of water be allowed to fall gently upon it, the soft substance will be washed away, leaving the connecting tissue. When the cream-like matter is examined in the microscope, it is observed to be made up of innumerable fragments of nerve-tubes, granules, oil-globules, and amylaceous cells, the débris of medullary tubes and ganglion-cells. A tinge of yellow pervades the softened and neighbouring parts. The membranes do not commonly present any decided signs of having been implicated, nor is the vascularity much altered.

It will depend on the depth to which the morbid action reaches, in any particular case, as to the functions of the cord which will be abolished. We owe to modern discoveries the knowledge of the fact, that to the anterior column, from which the anterior roots of the spinal nerves arise, belongs the power of controlling the muscles; and that to the middle lateral column, from which the posterior roots arise, belongs sensation. Hence if the disease penetrate only so far as to destroy one column, leaving the other sound, we may anticipate that the function pertaining to the disorganised column will alone be lost.

Now extensive experience proves that, in the paraplegia caused by disease of the spine, one of the two properties conferred by the cord, namely, motor power, is in a remarkable degree more frequently destroyed than sensation. So general is this fact, that it may be regarded as a comparatively rare event for both motion and sensation to be lost simultaneously. As to the reverse kind—abolition of sensation while motor power is retained—it is doubtful whether such a case was ever met with.

When we consider the relative position of the different columns of the cord to the centre of disease in the spine, the cause will be at once apparent why motion should be first destroyed. The anterior column, that on which power over the muscles depends, is separated from the bodies of the vertebræ only by the theca vertebralis and other delicate membranes of the cord. Hence when the morbid action proceeds backward, and infects the medulla, we may anticipate that the column of motion will be deprived of its function before any other. And its liability to be so involved will be increased by the compression to which it is peculiarly subject from the bending of the spine, as it forms an acute angle at the part.

But an additional reason may be stated why motor power should thus be lost before sensation. It seems capable of proof, that the proper seat of the latter property is deep, and near the centre of the medulla. That opinion is supported by observation of the different modes in which the two roots of the spinal nerves are connected at their terminations with their respective columns. If we trace a filament of an anterior root to its source, we shall find that, as it is about to join the cord, it subdivides into numerous minute radicles, and that these lose themselves almost imperceptibly on the surface of the anterior column. If, on the other hand, we trace a filament of a posterior root to its destination, we shall observe that it maintains itself as a single, entire fibril, up to the cord; that when arrived there, it dips bodily, without subdivision or change, into the fissure between the posterior and middle lateral columns; that while in the fissure, it pursues an unbroken course to the bottom; and that its actual termination is in the deepest part of the cord, where the central cineritious matter is situated. It appears, therefore, from this anatomical evidence, that the part of the medulla appropriated for sensation must be in the internal, well-protected recesses of the organ; where it is less likely to be reached by disease invading the exterior, than the column of motion, situated more superficially.*

It will depend on the part of the spine where the caries exists, as to the extent of the body that will be paralysed. If the cord be affected high in the column, a large portion, including, perhaps, the upper extremities, will be deprived of motion, — it may be motion and sensation conjointly; if low, the inferior extremities alone will have paraplegia. Should the disease be seated in the lower lumbar vertebræ, that is below the termination of the cord, there may be an absence of paralysis: unless, as occasionally happens, the products of inflammation have extended upward, to involve the medulla above. In not a few cases, one lower extremity is more completely deprived of motor power than the other, indicating that the corresponding side of the cord has been more extensively destroyed.

Comparing the paraplegia resulting from disease with that from injury, it is remarkable that the former is seldom accompanied with loss of command over the bladder or rectum; and that when these organs are affected, it is commonly to a partial degree. The patient, retaining sensation, may have an urgent desire to pass water, but will be unable to do so, and will require the assistance of the catheter. Again, the stools may pass at one time involuntarily, at others with his consciousness. In general, the torpidity of the bowels renders it necessary to give aperients frequently.

The cases are comparatively rare in which the loss of power in the limbs leads to the formation of bed-sores. If the patient be an adult, and he has great pain at the seat of disease, making it difficult to turn him, so as to shift the position of his legs, there is danger of the skin over the sacrum ulcerating, or being converted into a slough. But the risk is not so great as in cases of paraplegia from fracture of the spine, when the fæces and urine pass involuntarily, and the hips are constantly sodden in the filthy moisture. In a young person, on the other hand, whose body is light, and who, from possessing sensation, can feel the irksomeness of lying for a long time in the same posture, we do not look for sores; he is able of himself, with the use of his hands or elbows, to change the position of his hips, and avoid the bad effects of pressure.*

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* In 1834, several years subsequently to his discovery of the distinct functions of the roots of the spinal nerves, Sir Charles Bell was brought to conclude that the proper origin of the posterior roots, and therefore the true seat of sensation in the cord, was the middle lateral column, and not, as he had previously thought, the posterior. He was led to the observation by finding in the works of preceding anatomists, that the larger ganglionic root of the fifth nerve of the brain, which he had proved to be analogous in function, as well as structure, to the posterior roots of the spinal nerves, could be traced downward from its apparent origin in the pons Varolii, to the top of the spinal cord, close to the origins of the posterior roots. He perceived also that, in its long transit, it kept at a distance from the posterior column of the cord. Not long after the publication of this view, cases were recorded which confirmed it so far as to prove that sensation did not belong to the posterior column. Of these, the most interesting was one related by Mr. Stanley, in which that column, in a great part of its extent, was thoroughly disorganised; and yet the sensation of the corresponding part of the body was unimpaired. *Trans. Med.-Chir. Soc.* vol. xxiii. p. 80.

Spasmodic actions of the paralysed limbs. When the lower extremities are entirely bereft of voluntary power, they are subject, nevertheless, to be affected with convulsive actions, through some obscure morbid influence acting on the distal portion of the spinal cord cut off from connexion with the brain. The spasms which are met with in paraplegia consequent on caries of the vertebræ, are the same that we witness when the cord has been destroyed by violence, or by the encroachment of tumours, ramollissement, &c.

A frequent form of the attack consists in a sudden jactitation of one or both legs. While the patient is lying quiet, the limbs will suddenly, and without warning, be bent both at the knees and hips, —so that the heels come in contact with the back of the thigh, and the knees with the abdomen:—the flexor muscles will then relax, and the limbs will fall straight, as before. In such cases the spasms are of short duration; but they may be repeated with great frequency, so as to cause considerable distress to the patient.

A different form consists in the legs being drawn up, and then remaining bent. In these cases, the limbs and body will be so rigidly fixed, that the patient will be moved about in bed, in one mass, like a log of wood.

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* Before any other physiologist, at home or abroad, had participated with Sir Charles Bell in investigating the distinct functions of the nerves by experimenting on their roots—Mr. John Shaw had applied the discovery made by the former, that the anterior roots of the spinal nerves bestow motor power, and the posterior sensation, confirmed by the corroborative observations on the roots of the fifth nerve and portio dura of the brain, to solve the pathological problem treated of in the text. In his Paper on "Partial Paralysis," the following question formed one of the head-titles: "Why Sensation should remain entire, in a Limb, when all Voluntary Power over the actions of its Muscles is lost; or why Muscular Power should remain, when Feeling is gone." The explanation of the problem which Mr. Shaw then gave, and the account of the appropriate functions of the anterior and posterior roots of the spinal nerves on which it was founded, were essentially the same as those presented above. That paper was read to the Royal Medical and Chirurgical Society in April 1822. It was not till August of the same year that M. Magendie published his supposed original experiments on the roots of the spinal nerves.

Cases will be met with in which both the above forms will be presented, at different times, in the same patient. The spasmodic actions, whether clonic or tonic, are apt to be excited by certain irritants. Thus tickling the soles of the feet, pinching or pricking the skin, the act of moving, will bring on the sudden startings, or will aggravate the contractions of the rigidly bent limbs. Micturition and defæcation sometimes, but rarely, excite attacks. Yet they frequently come on without any perceptible cause of irritation. When the patient is drowsy and about to drop asleep, he is peculiarly subject to be woke up by the limbs jumping.

The pain occasioned by the spasmodic affections is sometimes excessive. In certain cases it equals, if it does not surpass, the agony of tetanus in its worst form; happily, in the majority of patients the suffering is moderate and endurable. But independently of the pain in the limbs, there is an indirect evil. When the convulsions are strong, they shake the whole body, and communicate a jar along the spine, to the diseased vertebræ. Again, if the patient have bed-sores, the concussion produces friction of the hips against the bedding, and that aggravates the ulceration or sloughing. Owing to the elasticity of the figure in young persons, these effects may not be perceived; but in adults they are very marked.

When it is attempted to subdue the spasms by applying splints to the limbs, or bandaging the leg that is affected to the one that is quiet, and fastening them, when thus secured, by india-rubber tubing to the bedposts, the plan commonly fails; the skin is liable to be frayed, and the pain is not diminished. There is no particular medicine that can be relied on for overcoming the convulsions. Some good effect may be expected from injecting morphia under the skin.

Diagnosis. As intimated before, paraplegia consequent on caries of the vertebræ does not differ materially from palsy of the lower extremities caused by morbid affections of the cord, of various distinct kinds. Indeed, it is chiefly owing to the medulla being subject to lose its functions from several different diseases, and to the effects produced in each being much alike, that accuracy of diagnosis is difficult.

The principal diagnostic sign of paralysis in spinal disease is, doubtlessly, the angular deformity. Extensive observation shows, that when paraplegia is connected with caries, it always occurs late in the disease, after the bodies have been deeply excavated. Consequently, if there be an absence of the decided projection of one or more spinous processes, or rigidity of the vertebræ, which indicates destruction of the column by caries, it may be assumed that the paraplegia depends on some other morbid affection. Again, it is generally characteristic of palsy arising from caries, for motor power to be abolished while sensation is unimpaired. It is true that this sign is not constant, and that in several other affections of the cord the same peculiarity may be observed; yet it is more frequent in cases of caries than in others. If the reverse be found, namely, loss of sensation with retention of motor power (a rare concurrence), it may be inferred that the cord is encroached upon by some morbid growth advancing from behind forward.

Should Cancer attack the spine, it may lead to a deformity not unlike angular curvature; also to paraplegia, which may be attended with painful spasms, and other severe and fatal effects. When treating of Abscess (see p. 857), it was stated that if an encephaloid cancer protruded by the side of the spinal column, it might be mistaken for a collection of pus. But this malignant disease, especially of the scirrhous kind, affects the bones of the spine more directly than that description implies. To all conversant with the pathology of scirrhus, it is known that after it has been seated in a particular organ, as the mamma, and the whole system has become infected, the peculiar morbid product of cancer is frequently deposited in the internal structure of the bones generally. Thus the vertebræ are liable to be infiltrated throughout all their interior, including bodies, arches, and processes, with cancer-matter, which takes the place of the normal tissues. Cases are not wanting in which the disease appears to have attacked the bones of the spine primarily.* But in the majority of cases of cancer in the vertebral column, the disease is only a part of an extensive invasion of the osseous structure; and it is more frequently associated with scirrhus of the female breast, than with any other form. When the vertebræ are subjected to the morbid interstitial change, so that their solid material is given up for the soft tissue of cancer, they yield, as might be expected, to the pressure of the superincumbent weight, and deformity of the column ensues. It is a striking feature of the affection, that no part of the spine but the osseous is included in the morbid change. Accordingly, when the longitudinal section of a spine so transformed is examined, a remarkable contrast is presented between the condition of the bodies of the vertebræ, and that of the intervening fibro-cartilages. The latter retain their natural thickness, firmness, and glistening whiteness; while the bodies are not only converted into a fleshy, pale, amorphous substance, destitute of a vestige of cancellated bony structure, but are compressed and flattened, so as to be, in some parts, nearly obliterated. Outgrowths of cancer are apt to protrude irregularly into the vertebral canal; and the medulla is deprived of its functions, either through them, or the rapid displacement of the vertebræ in relation to the canal. Cases of this kind are readily to be distinguished, in general, from those of caries, by other parts of the body besides the spine being at the same time infested by cancer.*

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* See a paper on "Cancerous Disease of the Spinal Column," containing many instructive cases, by Mr. Cæsar Hawkins,—*Trans. of Med.-Chir. Soc.* vol. xxiv. p. 60.

Prognosis in paraplegia. Observation proves that restoration of the power of the limbs, when lost from the effects of disease of the spine, is much more frequent than when caused by fracture of the column, or softening of the cord, &c. The explanation appears to be, that when a portion of the medulla has been disorganised and deprived of its function in consequence of caries, an opportunity is afforded, owing to the continued bending down of the column into an angle, for the sound parts above and below to come into contact, and displace the diseased part, so as to unite and be able to resume their functions. Such a reunion of the upper and lower portions, it is obvious, cannot be effected when the cord has been indelibly crushed for a considerable extent, or has been torn completely asunder, in a case of fracture and displacement of the vertebræ. And the same remark applies to destruction of the medulla by disease, when the spine is straight; for there will be no possibility, should the morbid action cease, of the ends above and below approximating and restoring the continuity of the organ by adhering; and it is not probable that the intervening lost part will be replaced by newly-produced structure. Another ground for entertaining hopes of recovery in cases of caries, is the fact, that the loss of substance in the cord is usually confined to the anterior column; it is reasonable to expect that from the part that has been disorganised being so small, it will be replaced by healthy structure.

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* In the essay on CANCER (vol. i. p. 514), a case is referred to, in which the patient, a female, forty-six years of age, under Mr. Moore's care, had cancerous tumours in both breasts, with infection of the axillary glands; and in whom the spine, in common with the skull, became secondarily affected. In the dorsal region she had two angular curvatures. She had also lost muscular power and sensation in the lower extremities. Since the publication of the volume, the patient has died. The following is a description of the preparation of the spine preserved in the museum of the Middlesex Hospital, from notes furnished by Mr. Moore: The specimen exhibits a vertical section made through eight lower dorsal and all the lumbar vertebræ. Cancerous matter has been deposited in the bones of the column, and exclusively in them. The effects are most distinctly visible in the bodies, which have become subsequently absorbed. The intervertebral cartilages are of the usual thickness, and preserve their normal structure. Some of the vertebræ have been much more absorbed than others. The body of the seventh has been reduced to half an inch in depth; those of the ninth and tenth to about an eighth of an inch respectively; of the twelfth to half an inch; of the second to about an eighth of an inch; the body of the third lumbar vertebra has been almost entirely absorbed, so that the intervertebral fibro-cartilages above and below come nearly in contact with one another. At those situations where the bodies have been most absorbed, the vertebræ generally have been compressed, and the column correspondingly diminished in height. On the left side, the cancerous deposit extends beyond the bodies of the lower dorsal vertebræ, and has involved and compressed the spinal nerves at their exit from the intervertebral foramina.

Should the spine from ankylosis have been rendered incapable of bending sufficiently, before reparative action in the medulla can have taken place, the chances of recovery will be diminished.

In children, the prognosis is more favourable than in adults. This difference we may principally attribute to the greater flexibility of the spine, in early life, which will facilitate proportionately the coalescence of the sound parts of the cord. The writer had lately under his care a boy, six years old, with angular deformity in the dorsal region. Within a period of two years, his lower limbs were twice completely paralysed: the first time, for six months; the second, after an interval of eight months, for four. He recovered from the paraplegia, but afterwards died from the effects of extensive abscesses.

The restoration of the power of the limbs, in some cases, is only partial. Certain groups of muscles continue paralysed. This inequality in the condition of the muscles leads to particular forms of contractions and deformities, chiefly in the ankles and toes.

DISEASE OF ATLAS AND AXIS.

Disease affecting the two highest vertebræ of the spine has certain peculiarities which entitle it to separate consideration. The same cause which makes accidents to these bones more dangerous than elsewhere,* renders morbid action more perilous. The portion of spinal cord contained within the ring of the atlas, is the most vital in the nervous system. Hence, whatever tends to weaken the joints in that part, exposes the patient to the hazard of sudden death, or paraplegia, including the whole body below the head.

Both atlas and axis, especially the former, differ from the other vertebræ in their anatomical structure. The atlas is deficient in the part that corresponds to a body; and there is no fibro-cartilage either between the axis, or the occipital bone and it. Hence, as these structures are the proper seat of caries, it may be expected that the morbid process which attacks the two bones will differ from the ordinary disease of the spine.

The joints particularly subject to be affected are those between the atlas and axis. And a reason may be assigned for their being peculiarly prone to disease. The term 'axis' implies that the vertebra so called is the centre of the rotatory movements of the head. Now as the spokes in a carriage-wheel inserted into the axle act upon that central point with great lever power, and when a break-down occurs it is the axle that gives way, so a corresponding impulse is directed upon the pivot of the axis, by sudden violent rollings or twistings of the head. These shocks and sprains, often repeated, predispose the articulations, in a delicate patient, to disease.

The morbid action thus set up in the atlo-axial joints resembles disease as it most commonly occurs in the wrist, elbow, knee, &c. Proceeding generally in a chronic form, it gives rise gradually to a softening and spongy thickening of the synovial and fibrous tissues that connect the vertebræ; and to ulceration of the cartilages, and superficial corrosion of the bony structures. The disorganisation will go on in most cases to an extreme degree, without visible signs of abscess.

That which contributes principally, as intimated before, to the importance of disease in this locality, is the danger threatened to the spinal cord at its most vital part. Owing to the head being sustained on the atlas, and the ligaments which bind the latter and axis together being unable to retain them in position, the weight of the head is liable to cause the atlas to glide forward and downward upon the axis. This movement implies that not only are the articular surfaces of the oblique processes separated from each other, but that the odontoid process of the axis is detached in an equal degree from the surface of the atlas on which it turns. Now it is in this last-mentioned change more than any thing else that the risk to the spinal cord consists. The anterior arch of the atlas cannot be separated from the odontoid process, except by the stretching and elongation of the transverse ligament which embraces the neck of the process, and of the accessory restraining ligaments. Accordingly, if the weight directed on the atlas should be suddenly increased while this extension is in progress, and the ligaments are correspondingly weakened, the danger is imminent of the latter being ruptured. And should that event occur, there would be nothing to prevent the atlas, impelled by the weight of the head, from sliding abruptly forward on the surface of the axis to its utmost reach. The consequence of this consecutive dislocation would be, that the peculiarly vital portion of the spinal cord, contained within the ring of the atlas, would be suddenly propelled by the posterior arch of that bone against the odontoid process in front, so as to be thoroughly crushed between them. Its functions would thus be abolished at once, and the patient's death be instantaneous.

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* See Injuries of the Back, vol. ii. p. 215.

But, happily, the termination of these cases is not always so formidable. In not a few, the transverse and restraining ligaments undergo stretching of their fibres without being ruptured. They continue, therefore, to retain a hold of the atlas; and to keep a check upon it as it glides forward upon the axis. Besides, the general connecting structures around the diseased vertebræ are agglutinated together, from deposition and condensation of coagulable lymph. Accordingly, the shifting movement proceeds slowly and gradually. Yet the displacement may take place to an extraordinary extent. In many cases the atlas will be transported to the front to such a distance that less than one-half will remain resting on the axis, the anterior part protruding unsupported beyond its level. When the dislocation amounts to that degree, it follows that the posterior arch of the atlas will cease to be in relation to that of the axis. It will be carried so far forward horizontally that it may even bisect the vertebral canal into equal parts. Hence about a moiety of the area appropriated for holding the spinal cord will be absolutely cut off. Now it might have been expected that the loss of material, as well as change of figure, in the part of the cord that had to accommodate itself to the canal when so extensively altered, would be incompatible with its performing its functions. Nevertheless it is found by experience that, however much curtailed in its proportions, bent, and twisted, the portion corresponding to the distorted and contracted canal may be, the whole change in the cord may be effected, without paraplegia. It is also known that if paralysis, including both upper and lower extremities, should ensue, the patient, notwithstanding the alteration of structure, may recover; the dislocated vertebræ will be securely ankylosed; he will be strong and fit for any occupation; and his only defect will be a stiff and somewhat contorted neck. The phenomena are to be accounted for according to the pathological principle already adverted to (p. 859). The diminution in the substance and disfigurement of the cord generally, have been consequent on a slow process of interstitial change; and it has been seen that deviations from the normal size and shape, of the most surprisingly great kind, can be made in the spinal cord, as well as the brain, without sacrifice of their endowments, if wrought in that gradual manner.*

As in spinal disease generally, persons of scrofulous habit are most prone to be affected in the atlo-axial articulations. The last case observed by the writer was in a young woman, who, just after recovering from disease in these joints, had angular deformity from caries in the dorsal vertebræ. The most common age at which it commences is near puberty; but neither infants nor adults are exempt.

Symptoms. A general swelling around the nape of the neck, attended with stiffness, and pain in motion, are the earliest indications of the disease having set in. The patient will prefer the recumbent position to being erect; keeping his head sunk in a soft pillow. When upright he will steady his head by placing a hand on each side; and if asked to rotate it, he will stiffen his neck, and turn the whole body round. The nodding motions he will be able to perform. A sudden jolt, or a tap with the hand on the crown of the head, will give pain. As the swelling of the upper part of the neck may probably be mistaken, at first, for inflammation of the lymphatic glands, or deeply seated abscess arising from some other cause, the most certain mode of deciding the question as to the real nature of the disease, is to observe accurately the relative position of the spinous process of the axis to the occiput. Notwithstanding its large size, that process is not readily felt in the normal condition; it lies sunk in a hollow, arched over by the ligamentum nuchæ. But in atlo-axial disease the spinous process becomes distinct, not only to the touch, but to the eye. That change, however, is not consequent on the axis itself protruding; for this bone is stationary. The spinous process appears to project, merely because the atlas, carrying the skull upon it, glides away to the front, thereby leaving it more exposed and defined. In conformity with this explanation, it will be perceived that the head droops, as it were, upon the neck; that the chin and face generally are advanced preternaturally forward in comparison with the throat; while the back of the head is deficient in rotundity and fulness in reference to the line of the spine. It may happen that one side of the atlas will move forward more than the other; when there will be added a little obliquity to position of the head.

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* In a specimen of consecutive dislocation of the atlas upon the axis, of which Mr. Paget has given an accurate description, the displacement exceeded what has been stated in the text. Fully two-thirds of the atlas must have been entirely thrown off the surface of the axis, leaving one-third alone seated upon it. Taking the measurement of the part of the vertebral canal available for holding the spinal cord, it was found that the distance was only two lines from the odontoid process, and three lines, at the most, from the body of the axis to the posterior arch of the atlas (the normal measurements being from nine to eleven lines). In the neck of the odontoid process there was a deep indentation, which proved that the transverse ligament had retained its hold of the atlas to the last without being ruptured; and that the displacement had therefore been slow. In another specimen, described by the writer as a sequel to Mr. Paget's, the dislocation and measurements of the vertebral canal were about the same. It differed in having a thick bony connecting-rod, two-thirds of an inch long, formed between the anterior surface of the odontoid process and the posterior surface of the anterior arch of the atlas; that is, between the surfaces which had originally been articulated with each other, but had been thus widely separated by the effects of the disease. It may be inferred that, unless the process of displacement had been slow, a beam of osseous structure of that description could not have been formed. *Med.-Chir. Trans.* vol. xxxi. p. 285.

Prognosis. Many patients pass through all stages of this complaint, till it ends in deformity and ankylosis, without decided indication of the spinal cord being affected. Yet the Surgeon cannot fail to be in constant apprehension, and to watch every symptom narrowly. Pains darting upward to the back of the head, and simultaneously downward over the shoulders and clavicles, perhaps give the first alarm. The latter sensations are sometimes prolonged to the finger-ends, accompanied with slight muscular weakness. Such symptoms alone might be explained by supposing that the roots and trunks of the nerves given off from the cord in the neighbourhood of the disease, had become affected by the process of displacement, and morbid action external to the spine, without the medulla itself being involved. But prudence will not allow that view to be too much relied upon. Should there be added any symptom of the lower extremities becoming paralysed—as a tendency to trip in walking, or a sense of pricking or of numbness in the feet—the conclusion will at once be drawn that the morbid action has penetrated to the medulla. In certain cases the paralysis of the lower and upper extremities will be but imperfectly pronounced; and it will pass off. In a solitary case seen by the writer, the muscles became affected with tonic spasm; the whole body was so rigid, that on turning the patient in bed, she rolled with the stiffness of a person recently dead; that condition lasted for a month; it gave place gradually to ordinary paralysis,—from which she eventually recovered. When the paraplegia is complete, the patient is in a singularly helpless state, being devoid of voluntary power and sensation either in the upper or lower extremities. Yet, notwithstanding the apparent hopelessness of these cases, experience proves that they frequently end in perfect recovery. The prognosis will be, of course, more favourable in young persons than in those above the middle period of life. The writer, together with his colleague Dr. M. Crawford, attended a man, whose age was forty-eight, for disease in the atlo-axial articulations: during six months his whole body, from the head to the toes, was paralysed; yet he eventually recovered, with his neck merely stiff and distorted.*

Necrosis of atlas. Before quitting the subject of diseases of the upper vertebræ, a rare affection of the highest of them may be briefly noticed. This consists in necrosis and exfoliation of that part of the anterior arch of the atlas which corresponds, in other vertebræ, to the body. The disease is connected with ulceration of the back of the pharynx; and it has been commonly observed in syphilitic patients. In the recorded cases, the whole thickness of the bone has come away, as shown by the articular surface of the odontoid process being visible on its posterior aspect. From the patient's surviving, it cannot be doubted that the insertions of the transverse ligament had been preserved entire; and that it had retained its hold of the process. A sloughing ulcer in the posterior fauces, with occasional attacks of difficult deglutition and breathing, have been the most prominent symptoms. When the fragment has been picked away, the sore has healed, and the patient recovered. It need scarcely be said, that a patient who has such a threatening disease, in a situation of so much danger to life, is in a critical condition, while the dead portion of bone remains as a source of irritation: and that the greatest caution is demanded to protect him from sudden bending forward of the head.†

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* See the paper by Mr. Lawrence, "On Dislocations of the Uppermost Vertebræ of the Neck," in *Med.-Chir. Trans.* vol. viii. Also, "Lectures on Pain and the therapeutic Influence of Rest," by Mr. Hilton, *Lancet*, Oct. 20, 1860, p. 381.

† See case narrated by Mr. Keate, in the *Medical Gazette*, vol. xvi., 1835;

Treatment.

The general course of treatment necessary for spinal disease is the same that is required for most kinds of diseases of the joints; as morbus coxæ, scrofulous synovitis of the knee-joint, disease of the ankle-joint, &c. The remedies must be directed principally to sustain and strengthen a constitution originally weak, and liable to be further debilitated by the effects of the disease. Hence, although it may be occasionally necessary to employ depleting measures for subduing temporary accessions of fever, or quelling short attacks of inflammation, they are adopted with reluctance, and the tonic system is otherwise pursued uninterruptedly.

Of local remedies, 'rest' is deservedly placed at the head of the list. The object sought to be gained is twofold. First, by fixing the diseased vertebræ, we endeavour to prevent jarring and attrition between the rugged opposing surfaces of the carious bodies; and by removing that source of irritation, to encourage the morbid action to cease. Secondly, by keeping the bones at perfect rest, we afford the parts the most favourable opportunity for becoming consolidated by ossific union.

The most effectual method of arresting motion between the diseased vertebræ, in aid of nature's efforts, is to place the patient in the recumbent position on his back. And to give him the greatest advantages while confined, it is desirable that he should be furnished with an invalid-bed, provided with contrivances for enabling him to lie upon it, day and night, without rising. Should a bed of that kind not be procured, and an ordinary couch be used, the patient will lie with greater security and comfort if the frame for the horsehair mattress, instead of being horizontal, be gently inclined downward from the top to where the hips come; and then be elevated (but to a slighter degree), with a double incline, for the knees to be bent over the angle. A hollow, or socket for the reception of the angular projection of the spine, must be made in the mattress. Or a substitute may be contrived by filling an india-rubber pillow with sand, or suitable grain or seeds, and placing it under the patient's back, protected with blanket and sheet. In young persons, further security will be required, by enclosing the body in a stiff corset; and, perhaps, by strapping them

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"A case of Exfoliation of the Anterior Arch of the Atlas," by Mr. R. Wade, *Med.-Chir. Trans.* vol. xxxii. p. 65; Lectures by Mr. Hilton, *Lancet*, Oct. 27, 1860, p. 402.

down to the couch. It will add to the convenience if the bed-frame be portable, and capable of being easily transferred to the body of an invalid-carriage, or to a bench in the garden, with a view to the patient's getting fresh air.

It is an important duty of the Surgeon to exert a peremptory authority in enforcing confinement in the recumbent position. He will find this task, as might be expected, more difficult in children than in adults; and the principal cause is the patient's being free from pain in the majority of cases. No doubt can be entertained that, however moderate may be the symptoms with which the disease is ushered in at first, the incipient stage is a period during which a rigid and strict observance of perfect rest ought to be inexorably insisted upon. And the time over which that care should extend cannot be estimated, even in the most favourable cases, including children, under six or ten months. In patients approaching adolescence, the confinement may be longer.

If the case should fortunately proceed without pain in the back, and without abscesses presenting themselves, for the number of months mentioned above, the next practical question will be concerning the propriety of liberating the patient from his long durance. That is equivalent to asking, how it can be ascertained that ankylosis shall have taken place; for it cannot be considered safe to allow the patient to get into the upright position till the bones have become knit. In making the examination of the angular projection, it will be carefully observed whether there be any motion between the affected bones; and if the part be perfectly stiff, it may be presumed that they are united. Should there be, at the same time, atrophy of the muscles in each trough by the side of the protuberant spinous processes, that will confirm the opinion. But it will not be prudent to rely on the solidity of the ankylosis being sufficiently great for the spine to support the body unassisted. The patient ought to be supplied with artificial supports. Space does not allow of a detailed description being given of the best kind of these instruments to be used in different cases; for, of course, they must vary, not only according to the situation of the disease, but the age of the patient. One general remark may be made, that the corsets ought to be constructed much in the fashion of women's stays, so as to embrace the body above and below equally and generally. In stiffening them with steel ribs, as preferable to whalebone, they ought to be strengthened as much to the front as practicable, so as to counteract the tendency to stooping forward. In young, feeble children, whose bodies are soft and extremely flexible, while their hips are too narrow for being used as a base of support, it may be found best to encase them in separate pieces of prepared leather, moulded to the body, and afterwards inserted in corsets; the lateral pieces or splints may be prolonged downward, to rest on the seat of the chair, and brought high enough to reach the arm-pits, so as to act as crutches while sitting.

Prone-couch. A mode of reclining in the prone position, instead of on the back, has been recommended, and put in practice. The method consists in making the patient lie upon his chest and abdomen, on an elevated frame, not unlike a desk, with an inclined board below, upon which his legs may hang: he is prevented from sliding by pegs at the top received into the arm-pits. The object of the position is, by fixing the upper part of the trunk, and allowing the hips and legs to glide down the incline, to keep the spine on the stretch, and so diminish the acuteness of the angle at the seat of disease. But such a design is opposed to the principles that have been advocated in a former part of this essay (see p. 845), and about which the highest surgical authorities coincide. It is evident that if the angular projection be diminished, it can only be done by separating from each other the surfaces of the diseased vertebræ which ought to coalesce, thereby preventing ankylosis. Moreover, as the patient cannot sleep, and cannot empty the bladder or rectum while confined on the apparatus, it will be necessary to move him frequently, to the great injury of the back.

But it will, perhaps, be said, that although the employment of the prone-couch be not adapted to caries in its active stage, it may be advantageously used, to improve the figure, when ankylosis has been effected. That desire in patients, who have made a narrow escape from a disease highly dangerous to life, at the price of being deformed, to have the cure made perfect by getting rid of the hump on the back, is a very natural one; yet it not unfrequently leads to their running into new dangers, in the hands of ignorant and unscrupulous quacks. In a former part of the article (see pp. 839-844), the objections to schemes which have for their object to elongate the spine, with the view of restoring the shape, have been stated; and they apply to this plan of using the prone-couch.

In disease of the atlo-axial articulations, the danger most to be apprehended is, that, from a violent falling forward of the head, the transverse ligament, in its stretched and attenuated condition, should give way; and that the atlas should thus be permitted to slide forward, and compress the spinal cord by its posterior arch. Special care is, therefore, required to keep the head and neck of the patient in a state of perfect rest. Accordingly, constant uninterrupted confinement in the recumbent position is imperatively demanded. And the patient's head ought to be laid on cushions, which will prop it equally on every side. For that object, the india-rubber pillow, stuffed to a proper degree of firmness with grain, so that it may be easily pressed into a hollow which shall fit the back of the head and nape of the neck, is to be used. Or the sand-bags recommended by Mr. Hilton will be more easily procured. A band ought also to be passed over the forehead, from the sides of the pillow, to restrain motion. In the event of the patient being restless and liable to lift the head inadvertently, as during meals or sleep, it is a useful precaution to have a shield moulded, either in gutta-percha, or prepared leather, to the back of the neck; this ought to take in the shoulders below, and reach to the vertex above, so that it may be secured by bands both to the shoulders and head, to arrest movement.

Counter-irritants. The period is not long past when issues, on each side of the protuberant angle, were almost universally ordered in cases of deformity from caries, whether the patients were young and weak, or the disease acute or chronic, or there were abscesses or paraplegia. The use of them was attended with much distress; and they had a debilitating effect on the constitution. According to the practice of the present day, issues are reserved for subduing any casual accession of the morbid action, when the pain in the diseased vertebræ is greatly increased, or there is a threatening of paralysis. They generally effect all the good they are likely to produce within a short time, and do not require to be kept open. Blisters are attended with so much inconvenience and pain, that they are seldom had recourse to. Happily the introduction of the compound tincture of iodine, as a local application, has supplied us with an efficient substitute for these coarser remedies. As in cases of diseases of the joints generally, it proves itself a most valuable agent in caries of the vertebræ. The mode of its use need not be particularly described.

In reference to the treatment of abscesses connected with diseased spine, there are no special instructions to be given. They require to be dealt with according to the general principles of managing large collections of pus that communicate with diseased joints.

ALEX. SHAW.

DISEASES OF NERVES.

INTRODUCTION.

TWO distinct groups or classes of symptoms may be caused by a lesion of a nerve: in one class the symptoms are the effects of the *loss of function* of the nerve; in the other, they are due to some *action* of the injured and irritated nerve. In the first class, therefore, the symptoms are due to altogether a different cause from that which exists in the second class.

Each of these two classes of symptoms may be subdivided. As there are four different kinds of nerves, four distinct symptoms of loss of function or cessation of action may be observed after a lesion of a nerve:

1st. There may be a paralysis of motion.

2d. There may be a paralysis of centripetal nerves (sensitive, incito-motory, &c.).

3d. There may be a paralysis of the vaso-motor nerve-fibres, in consequence of which the blood-vessels may be distended and full of blood.

4th. There may be a paralysis of the *nutritive* nerve-fibres (erroneously called *inhibitory*), in consequence of which nutrition is much less active.

It is not my purpose to dwell here upon these symptoms of absence of action caused by lesions to nerves. I will confine myself to the study of some of the effects of irritation of nerves. These effects may be grouped under two heads,—the *peripheric*, or *direct;* and the *remote*, *indirect*, or *reflex*. Of the peripheric, or direct effects, I will simply say that they give origin to four kinds of symptoms:

1st. Contraction of muscles.

2d. Referred sensations (formication, pricking, wrong feelings of heat, cold, &c.).

3d. Diminution in the quantity of blood, owing to the contraction of blood-vessels in the part where the injured nerve distributes its fibres.

4th. The reverse of the last effect when the irritated nerve-fibres are the nutritive (or inhibitory), with a morbid alteration of secretion or nutrition.

Of these four kinds of symptoms, three, viz. the first, third, and fourth, may also be caused by a reflex action. I propose in this article to treat only of these three kinds of reflex symptoms.

Hardly is there any affection that cannot be considered as having sometimes been produced by a reflex action, the cause of which is an injury, a disease, or, at least, an irritation of a nerve. If, instead of confining myself to the lesions of trunks and branches of nerves, I intended to describe the effects of irritation of the ramifications of nerves in the skin or in the mucous membranes, I could easily prove that most of the inflammations of the various thoracic or abdominal viscera take place through a reflex action, the starting-point of which is some irritation, by cold, of peripheric, sensitive, or centripetal nerve-fibres. I will not say more here about this influence of cold, as my purpose, as already stated, is to give an outline of the reflex effects of injuries or diseases of other parts of nerves than the network of their terminal ramifications.

Of the various reflex effects of irritation of centripetal nerves, the following are the principal, of which I propose to speak successively: *epilepsy*, *tetanus*, *hysteria*, *chorea*, and other *convulsive affections*, *paralysis agitans*, *paralysis* of various kinds (*hemiplegia*, *local paralysis*, &c.), *amaurosis*, *anæsthesia*, *insanity*, *delirium*, *coma*, *neuralgia*, and other *painful affections*, *inflammation*, *atrophy*, *and other morbid alterations of nutrition and secretion.* After having mentioned clear and positive facts, showing that all these affections may be caused by an injury to, or a disease of, a nerve, I will briefly give the rules concerning the diagnosis and treatment of injuries and diseases of nerves. This essay will therefore consist of two parts: the first, relating to facts showing the reflex effects of irritation of centripetal nerves; the second, the principal features and rules of diagnosis and treatment of diseases and injuries of branches and trunks of nerves.

PART I. DISEASES OF THE NERVOUS CENTRES AND OTHER ORGANS, CAUSED BY AN INJURY OR A DISEASE OF A NERVE.

Epilepsy. Of all the nervous complaints that may be due to an irritation starting from the trunk, branches, or ultimate ramifications of nerves, none, excepting the various forms of paralysis, is more frequent than epilepsy. Diseases of the mucous membranes, their irritation by worms, diseases of the cerebral meninges, irritation of the dental nerves, &c., are known to be frequent causes of this convulsive affection. But it is not so well known that an injury or a disease of a nerve in other parts than its terminal ramifications not rarely produces epilepsy. Some important cases show that no doubt can be entertained on this point. Sir Benjamin Brodie mentions the case of an officer in the army, who received a wound from a musket-ball in the leg. The wound healed, but the ball remained lodged in the flesh, in some deep-seated situation, where it could not be felt externally, and giving the patient no inconvenience. After some time the ball changed its place, so that it became perceptible to the touch; but then symptoms appeared which had never existed previously. There were convulsive twitches of the muscles of the limb, sometimes followed by a fit, in which there were general convulsions, as in epilepsy. The ball might have been easily extracted, but the opportunity was neglected, and the ball again shifted its place. "Probably," says Sir Benjamin, "it went back to the situation which it had originally occupied; at any rate, the spasms of the muscles were relieved, and there was no recurrence of the epileptic fits."* It is to be regretted that no more details have been given as to the symptoms of these fits; but it is not probable that the author would have called them epileptic fits, had they been simple reflex convulsions, without loss of consciousness and the other features of epilepsy.

A similar case is reported by a very able practitioner of Providence (U. S.), Dr. Parsons. He says: "I have recently met with the case of a soldier in our Mexican army, who had a bullet-wound at the battle of Molino del Rey. The bullet lodged; ten months after this he had a fit of epilepsy, and for three months after had them every two or three weeks. Dr. Kimball, of Lowell, Massachusetts, cut down and extracted the bullet, which lay near to, if not in contact with, the sciatic nerve, close to the ischiatic notch. Up to three months after the operation, when Dr. Kimball reported the case, no fit had occurred."†

In the following case, recorded by Dr. W. Laing of Aberdeen, it is quite clear that epilepsy was caused by an irritation arising from wounded nerves:—M. D., æt. 21, had the left hand lacerated by machinery. She went on well till the night of the 6th of March, when she was seized with convulsions; and after a day or two, with trismus and other tetanic symptoms. On the 7th of April she was dismissed, *cured;* but on the 24th of June she returned to the hospital. About a fortnight ago she suddenly fell down in an epileptic fit; and since, the attacks have become more and more frequent, recurring five or six times a day, and lasting about five minutes, after which she remained a considerable time in a state of stupor. On the 26th the fits were so severe that she was put in the strait-waistcoat. When the fits were slight, they were confined chiefly to the injured arm. On touching the fingers smartly, the arm was convulsively withdrawn; and when this was done while she was lying in a state of stupor, violent convulsions of the arm were produced. The patient often felt a sensation arising from the injured hand, previous to her fits. As the remainder of the hand was of little use, the fore-arm was amputated: the patient never had the slightest appearance of epilepsy after the operation, and was dismissed cured, a month afterwards. The digital branches of the median nerve, and a branch of the ulnar, were found enlarged to four or five times their usual size, and their extremities bulbous, and firmly imbedded in a hard cicatrix.*

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* *Lectures illustrative of certain Local Nervous Affections*, London, 1837, p. 14.

† Parsons, in the *American Journal of the Med. Sciences*, April 1851, p. 313; and Kimball, in *Boston Med. and Surg. Journal*, Feb. 14, 1849.

Sir Astley Cooper mentions a case of cure by excision of five-eighths of an inch of the radial nerve.†

It would be easy to accumulate facts showing that a disease or an injury to a nerve may cause epilepsy, and that by the section of the nerve, or by some other appropriate operation, this epilepsy may be cured.‡ I have seen and treated successfully several such cases, which will be found in a new edition of my work on Epilepsy.

There is also no doubt whatever that various alterations of nerves, not only of the limbs but of the trunk and of the internal organs,§ may cause a real epilepsy, absolutely similar to the idiopathic form of that affection.

Tetanus. As objections are daily made against the modern theory of the mode of production of traumatic tetanus, and against its rational treatment, and as also the writer of the article on TETANUS, in this work, has not discussed the important questions relating to the nature and to the local treatment of that affection, I will say a few words on these questions.

No one can doubt that it is owing to some peculiar influence exerted by the irritation of some centripetal nerve that tetanus is caused after a surgical lesion. An irritation starts then from a nerve, reaches the spinal cord and medulla oblongata, is reflected upon these very centres through their nutritive nerves, the nutrition of these centres becomes morbidly increased just as it is under the influence of strychnine, and then any excitation brings on reflex spasms. But whether this theory is the true one or not, I will not attempt to decide here, as my wish now is simply to show that this convulsive affection is truly dependent upon the irritation arising from injured nerves, and what the treatment should be.

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* Aberdeen Infirmary Reports, in *Lond. Med. Gazette* for Dec. 25, 1840.

† Lectures in the *Lancet*, 3d ed., 1826, vol. ii. p. 104.

‡ See my *Researches on Epilepsy, &c.*, 1857, passim.

§ Cappel, De Haën, Richter, Portal, Billod, &c., have recorded cases of epilepsy due to diseases of the phrenic, pneumo-gastric, and sympathetic nerves.

The relation between the wound and tetanus is clearly shown in those cases in which the muscles attacked with spasms are on the side injured. Lepelletier, Sir Gilbert Blane, Swan, Dupuytren, and Mr. Curling,* who cites the preceding authors, have seen such cases. My friend Dr. G. H. B. Macleod† relates two cases of fatal tetanus, in which the tetanic spasms were almost entirely limited to the side injured.

It may seem strange that tetanus will follow the slightest wound, that it will come at any period of inflammation or cicatrisation, and when there is no pain at all in the wound or its neighbourhood. But this is no objection to the view that it takes place by a reflex action, as we know that all the morbid or normal reflex actions may take place without any sensation, or, at any rate, without pain.

The kind of lesion that most frequently produces tetanus, implies that there is a great irritation of nerves, although there may be no marked pain. In a table given by Mr. Poland (in this work, vol. i. p. 607), we find that out of 1342 cases of major and minor operations at Guy's Hospital, there was but one case of tetanus; while out of 398 cases of compound fractures and 594 cases of wounds of all varieties, there were 18 cases of tetanus; giving a proportion, when the nerves were simply divided by a sharp knife, of one case of tetanus out of 1364 patients; and of one case out of 55 patients, after wounds and fractures, when the nerves were bruised or irritated by pressure.

The cases showing that tetanus may be cured either by an amputation of a limb or by section of a nerve, clearly prove the dependence of this affection on an irritation starting from some peripherical part of a nerve. Those who maintain that tetanus, when it has fairly begun, and attacked not only the head, but the trunk and limbs, cannot be cured by these operations, have not read the details of the cases of cure which have been published. No doubt, that in many cases in which the spinal cord is either inflamed or rendered extremely excitable, the section of a nerve or an amputation will be of no avail; no doubt, also, that if an inflammation has been propagated high up in the trunk of a nerve, towards its roots, these operations will be useless; but it is, nevertheless, most important to give the chance to the patient. I need not say that the simple division of a nerve will always be preferred to an amputation, unless there are some special reasons for this last operation.

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* *A Treatise on Tetanus*, London, 1836, pp. 87, 174.

† See his excellent work, *Notes on the Surgery of the War in the Crimea*, 1858, pp. 155-161.

Hysteria. The extreme frequency of this affection in women renders it difficult to prove that sometimes an irritation of a nerve is its cause. However, there are cases in which it seems quite clear that hysteria is due to a wound, or cured by the extirpation of a tumour; leaving hardly any doubt that this affection, like all others, may be the result of an irritation of a nerve.

Two very interesting cases are related by Dr. Parsons;* one observed by himself, the other by Dr. S. P. Hildreth. The first of these cases was that of a young girl, æt. 17, who, after a wound of the left thumb, was attacked with pain in her arm, neck, and head, and, after a few weeks, of a hysterical, barking, dry cough, almost incessant while she was awake. After the removal of the cicatrix she improved gradually, though slowly. Six or seven months after, a relapse occurred, when, on the apparition of a slough on the wounded finger, her barking mended; and after the separation of the slough her cough ceased, and has not troubled her since.

Morgagni mentions the case of a young girl who, after a wound to a finger by the biting of a sparrow, was attacked with fits of trembling and screaming, recurring sixteen or eighteen times a day.†

Raynaud relates the case of a woman who, after having received a blow on the breast, had a first attack of hysteria. Two small tumours soon appeared at the injured place, and for seven years hysterical attacks occurred several times every day. These tumours were removed by Boyer, and immediately after the operation the attacks ceased, and did not recur again.‡

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* *American Journ. of the Med. Sciences*, April 1851, pp. 307, 312.

† *De Sedibus et Causis Morborum*, Lutetiæ, 1822, vol. vi. p. 613, epist. liv. § 45.

‡ Raynaud, in *Archives de Médecine*, 1829, vol. iii. p. 434.

Three years ago, in a patient of mine of a highly nervous temperament, but who never had had any marked symptom of hysteria, convulsions and delirium, with some degree of lock-jaw, frequently appeared, and ceased for three or four days, after a slight wound by a needle in the front of the knee-joint, just below the patella. The needle broke at the time of the accident, and a small part of it remained under the skin. As soon as the pain ceased in the little wound, after the extirpation of the point of the needle, the patient got well, and has had no return of hysterical symptoms since.

Brachet has seen a temporal neuralgia produce hysterical fits every time it appeared, and for all the time it lasted.*

Sir Benjamin Brodie mentions several cases in which a wound was the cause of hysteria. In one of the cases, a young lady, æt. 11 or 12, pricked a finger with a pair of scissors. The arm was soon convulsed, and by degrees the other limbs were also affected with violent spasms. Various hysterical symptoms appeared, and recurred occasionally for two years.† In another case, hysteria was brought on by a fracture, and continued many weeks. The same patient, two years before, had been attacked with hysterical symptoms after a slight injury of the ankle.‡

In cases of cure of hysteria by an operation (whether the nervous complaint is due to an external cause or not), we must remember that any great impression on the nervous system, either moral or physical, may, as has been well shown by Sir Benjamin Brodie, cure the patient at once. That hysteria will sometimes return after an operation that had seemed to be successful, is also clearly established by the following case, narrated by Sir Benjamin: A young woman, after having been bled, had pain extending from the cicatrix along the arm, and on the side, leg, and foot. The arm was cold and purple. The cicatrix was excised, and there was an immediate relief. The wound having healed, she left the hospital as cured. Two months afterwards, however, similar hysterical symptoms showed themselves in other parts of the body.§

It results from the above facts, and from many other cases for which I have no room, that hysteria, like epilepsy and tetanus, may be caused by an irritation of a nerve.

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* *Traité de l'Hystérie*, 1847, p. 253.

† *Lectures illustrative of certain Local Nervous Affections*, 1837, p. 40. In this work Sir Benjamin does not say how long the patient remained hysterical; but he mentions this point in the *London Med. Gaz.*, 1836.

‡ Loc. cit. p. 46.

§ Loc. cit. p. 83.

Chorea. Even St. Vitus's dance may be caused by an injury to a nerve. Dr. Borelli, of Turin, has sent to the Paris Société de Chirurgie a case of chorea, caused by a neuroma of the foot, in a child 13 years old. The convulsive affection had lasted five or six months, and was at once diminished, and in four days cured, after the extirpation of the neuroma.* Prof. Andral mentions a case of chorea caused by the irritation of a finger by a retroverted nail.†

Hydrophobia. No clear, positive case of this terrible affection, when caused by the bite of a rabid animal, has ever been cured, either by the section of a nerve or by any other means, so far as I know. Already in the last century, however, Mr. G. Hicks proposed the division of nerves as a means of treatment against hydrophobia.‡ Dr. Stokes, of Dublin, has kindly communicated to me a most important case, showing that there is good ground to hope that hydrophobia might sometimes be cured by the division of a nerve.§

Tremulous movements. The so-called *trembling palsy*, which so often consists simply in involuntary tremulous movements, without any palsy, may be caused by an irritation starting from a nerve. Sabatier|| relates the case of a young man who, after a wound of the saphænous nerve, near the knee, was attacked with violent trembling of the leg and thigh, which lasted many months. In a patient sent to me by Mr. Erichsen an injury to a nerve of the left arm has produced trembling in both arms. In some cases the shaking becomes general.¶

Rotatory convulsions. I have found that an injury to the auditory nerve in animals is at once followed by rotatory movements. I do not know of any case of a wound of that nerve in man having produced the same symptoms; but several cases are on record in which these movements have been observed in man when the auditory nerve was irritated by an inflammation or some other cause (an injection of caustic, &c.). I would refer for these cases to my work on the *Central Nervous System*, p. 195.

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* *Gazette des Hôpitaux*, 1850, p. 454.

† *Cours de Pathologie interne*, vol. iii. p. 304.

‡ *Lond. Med. and Phys. Journal*, vol. xvii. p. 277.

§ The case above mentioned, and the reasons I have for the hope I have expressed, will be found in the Appendix to my work, *Lectures on the Physiol. and Pathol. of the Central Nervous System*, 1860, p. 261 et seq.

|| *Médecine Opératoire*, vol. i. p. 254.

¶ *An Inquiry concerning Constitutional Irritation*, by Benj. Travers, 1826, p. 115; and a *Treatise on Diseases and Injuries of Nerves*, by J. Swan, 1834, p. 124.

Rotatory movements are also sometimes caused by an irritation of another nerve. I have found that tying the blood-vessels and nerves of one of the supra-renal capsules sometimes causes, after eight or nine hours, rotatory movements to take place; but I do not know of any case in which this symptom has been observed when the supra-renal capsules have been diseased.

Reflex paralysis. Every form, every kind of paralysis, has been produced by a reflex action caused by an irritation of a nerve. In children, especially, reflex paralysis is very frequent. In adults, the muscles of the eye are very often paralysed by a reflex action.

I would refer to my work on *Paralysis of the Lower Limbs* for the mode of production of reflex paraplegia. I will only try to show here that a wound or a disease of a nerve may produce either a local paralysis or a hemiplegia.

I will not relate individual cases to prove that the iris may be paralysed by a reflex action. A neuralgia, or an irritation of a dental nerve, coming when the pain comes, and diminishing or ceasing with it, are so often the causes of mydriasis, that it is not necessary for me to mention cases of which every medical man has seen or heard of. The various muscles of the eye, the recti, and oblique, and also the elevator palpebræ, have been found paralysed, either each alone or several together, in cases of wound of the infra- or supra-orbital nerves, or in cases of neuralgia. I have seen several cases of that kind of paralysis (caused by a neuralgia), and all characterised by their evident relations with that cause.

In a case of reflex paralysis, which I have carefully watched, a sprain of *one arm* at the elbow-joint soon produced a paralysis of *both arms*, but more marked in the uninjured arm than in the other. Every change in the degree of pain in the injured elbow was accompanied by a corresponding change in the degree of the paralysis; and up to the time I write these lines, the pain having ceased for several years, the paralysis, which ceased with it, has not reappeared, and the two arms have as great power as they ever had before the injury.

Cases of hemiplegia owing to a neuralgia are much rarer than cases of local paralysis limited to a part of a limb, to the face, the eye, &c. Dr. Shearman has published a most interesting case of hemiplegia of the *right* limbs, caused by tic douloureux of the *right* inferior maxillary nerve. The patient was cured by tonics and galvanism.*

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* *Provincial Med. and Surg. Journal*, May 15, 1844.

I have collected seventeen cases in which there was hemiplegia, due to a reflex influence, starting from an irritation of either the trigeminal nerve near its origin, or of the crus cerebelli. I have shown elsewhere that the paralysis in those cases is a reflex one.*

Sir Astley Cooper mentions the following fact: "Mr. Toulmin attended a lady on account of her suffering severely from a diseased tooth, and she appeared also to be afflicted with hemiplegia. Mr. Toulmin extracted the tooth, and in a short time the paralytic affection entirely subsided."†

Anæsthesia. A reflex anæsthesia is not rare in cases of neuralgia. I have seen several cases of anæsthesia of the whole of one side of the face, in cases of neuralgia of one part of the trigeminal nerve on the same side. I have seen also a case of anæsthesia of a part of the forehead and face, in consequence of the irritation of a branch of the fifth pair on the cheek-bone by a bruise. In those cases the anæsthesia subsided when its cause was cured.

Amaurosis. Wardrop relates a case, in which the supra-orbitalis nerve was divided between the injured spot and the brain, and the amaurosis cured soon afterwards.‡ Notta, in an excellent paper,§ states that in ten cases of amaurosis caused by a facial neuralgia (either of the infra- or of the supra-orbital), the loss of vision was soon cured after the cure of the neuralgia. I have seen two such cases. In cases of this kind, the amaurosis increases during the attacks of neuralgia, and decreases afterwards. Dr. Noyes, of New York, has lately examined with the ophthalmoscope the retina of a patient (a medical man), who, after a blow on his forehead, had become amaurotic. The only alteration observed was a diminution of size of the central artery of the retina.‖ In an important case recorded by Mr. J. Hutchinson, the two eyes became amaurotic, in consequence of an injury to the supra-orbital nerve of one side. The ophthalmoscope showed that the retina and optic nerves were atrophied. The accident had taken place ten years before this examination.¶ I could, if necessary, mention many other facts showing that amaurosis may be produced by a reflex influence of an irritation starting from a centripetal nerve, and especially the trigeminal.

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* *Lect. on the Physiology and Pathology of the Central Nervous System*, pp. 201, 264.

† *Lect. on the Principles and Practice of Surgery*, 1824, vol. i. p. 6. Dr. Castle, of New York, mentions a case of paraplegia caused by decayed teeth quickly cured by the extirpation of the teeth (*Lancet*, 1846, vol. ii. p. 267).

‡ *Med.-Chir. Trans.* vol. xii.

§ *Archives gén. de Med.-Chir.* &c., juillet 1854, pp. 12-21.

‖ *American Med. Times*, March 15, 1862.

¶ *Med. Times and Gazette*, May 7, 1859.

Neuralgia. The frequency of *tic douloureux*, caused by an irritation of a small part of the dental nerves, is such, that it is certainly useless to mention cases. But tic douloureux may be caused by irritations of other nerves, while also an irritation of the nerves of the jaw may cause a neuralgia elsewhere than in the face.

Mr. Harvey has seen a case of tic douloureux caused by a tumour on the head; most likely pressing upon a nerve. It was ascertained several times, that pressure on the tumour brought on a severe attack of tic. The patient was cured by the removal of the tumour.*

In the case of a patient of Mr. Gay, there was a neuralgia of the various nerves of the leg, caused by a neuroma of the posterior tibial nerve near the os calcis. Excepting a pain remaining in two small branches of nerves, the neuralgia was cured at once after the removal of the neuroma.†

An injury to a nerve in one side of the body may even produce a neuralgia in the other side. A girl had a neuralgia of the *left* temple and side of the head, caused by a severe cut over the *right* parietal bone. A blister over the cicatrix relieved the patient for some time.‡ I have seen, with Dr. W. T. Gairdner, a case of neuralgia of one arm extending often to many other parts of the body, and caused by a wound of the hand.

Two cases of neuralgia of the arm, caused by an irritation of the dental nerve by a decayed tooth, are mentioned by Parsons, in an excellent paper on neuralgia.§ Both patients were cured by the extirpation of a tooth. Parsons relates also a case of neuralgia of the left ulnar nerve, following a neuralgia of the subscapular nerve, caused by a boil. After the healing of the boil, pressure on the scar would cause painful and strange thrilling sensations down the ulnar nerve.‖

Tavignot mentions cases of neuralgia of the ciliary nerves, and of several other branches of the trigeminal, caused by a wound of the cornea.¶

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* *On the Nature and Treatment of Tic Douloureux*, &c., by Dr. Henry Hunt, 1854, p. 114.

† *Lancet*, 1846, vol. ii. p. 119.

‡ *A Treatise on Neuralgia*, by R. Rowland, 1838, p. 18.

§ *American Journal of Med. Sciences*, Oct. 1854, p. 423.

‖ Loc. cit. pp. 423-4.

¶ *Gazette Médicale de Paris*, 1845, p. 547.

Dr. Greene, of New York, has cured a case of neuralgia of the face by extirpating a small tumour on the inferior dental nerve.*

The following case is so important that I give it almost fully. A woman, æt. 48, pricked the fore-finger of her right hand with a thorn. At first great pain, swelling, and redness, extending over the wounded finger and part of the middle one. After three months the pain and swelling went off, except that of the two first phalanges of the wounded finger. Nine months after the accident the finger was exceedingly painful to the touch, although there was only a light-red spot on the skin at the point. Two or three times a day there were attacks, during which the pain extended along the finger to the back of the hand, and between the two bones of the fore-arm, darted through the elbow-joint, stretched up the back of the arm to the neck and head, producing a sensation at the roots of the hairs as if they had become erect. To these feelings succeeded a dimness of sight, and the pain afterwards went suddenly into the stomach, followed by sickness and vomiting. She had constantly the feeling of a lump in her stomach, and always vomited after taking food or drink. The finger was amputated at the second joint. No sooner had she got into bed after the operation, than the sensation of a lump in the stomach and sickness immediately subsided, and in half an hour afterwards she said that she felt for the first time as well as she had done previous to the accident, except merely a slight pain in the stump. Her general health was soon completely reëstablished, and she never had the smallest return of any of the nervous symptoms.†

As a consequence of a blow on the inferior part of the orbit, a woman was attacked with an abscess, after which violent pains occurred almost constantly, radiating all over the face and the anterior, lateral, and superior parts of the head. This state lasted several years. Maréchal divided the infra-orbital nerve; and at once the patient was free from pain. The wound healed; however, the pains reappeared. The nerve was then destroyed by caustics, and the patient seemed cured. Ten months afterwards there were new attacks. The cicatrix was then opened, and kept suppurating, and the cure was definitive.‡

A case of sciatica, and another of flying pains in one-half of the body, are mentioned by Dr. Castle, of New York,* as having been cured immediately after the removal of aching teeth.

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* *Dublin Journ. of Med. Sc.*, 1838, vol. xiii. p. 53.

† Wardrop, in *Trans. of the Med.-Chirurg. Soc.* vol. viii. 1817, pp. 246 et seq.

‡ Case of Maréchal, cited by Marchal de Calvi, in *Annales de Chirurgie*, 1844, vol. iv. p. 69.

A great many other cases of neuralgia, caused by an injury to a nerve, might be mentioned. I will refer for several important cases to a paper of Marchal de Calvi† and to Romberg.‡

Delirium. I will simply mention here three cases which show quite decisively that delirium may be caused by an injury to a nerve. A boy, æt. fourteen, trod on a piece of glass which penetrated the big toe, but was removed. Four years after, he began suddenly to talk in a very strange, wild way; true delirium set in, and nothing appeased the patient. Near the ball of the big toe a small reddish elevation was found. The moment pressure was made upon it, the seizure returned with violence. An incision was made, and a trifling piece of glass was removed. Much as the patient had raved during the operation, with equal suddenness did all the symptoms vanish; and he was surprised on being told of all the senseless things he had uttered.§

I have published a case very similar to this, which I owe to the kindness of Mr. Campbell de Morgan, and in which the attacks of delirium took place every time pressure was made on a wound of a toe containing a foreign body. As soon as the irritated part was taken away by a cut of a bit of skin, the patient became rational, and remained so when pressure was made on the wound.‖

Mr. Sherwin has recorded a case of a woman who, after having been bled, was attacked with pains in the arm, neck, and face, with spasms in those parts, and delirium. After the symptoms had continued a fortnight, a deep incision above the cicatrix quite cured her.¶

I need not speak here of the delirium that follows amputation. The causes are many that bring on delirium after such an operation. Among the principal causes I will point out a great loss of blood, and the anxiety of the patient.

Inflammation. Cases of inflammation of the eye by a reflex action are so frequently met with, that I need not stop here to prove their existence. Any one who will read the facts published by Dr. W. Mackenzie, in his admirable work on the Diseases of the Eye, by Mr. R. Taylor,* and by Dr. Brondeau,† will soon be convinced that an inflammation of any part of one eye (the retina, the cornea, the conjunctiva, &c.) may be caused by a wound of the other eye; and that if the injured organ is extirpated, the other is soon cured. Cases of ophthalmia of an eye owing to a wound or a neuralgia of the infra- or supra-orbital nerves are also not rare.

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* *Lancet*, 1846, vol. ii. pp. 266, 267.

† *Annales de Chirurgie*, loc. cit. p. 76-80.

‡ *Lehrbuch der Nervenkrankheiten*, 3d ed. vol. i. pp. 23-35.

§ Joerdens, ap. *Hufeland's Journal*, vol. iv. p. 227, cited by Dr. Martin Payne in his *Medical and Physiol. Commentaries*, vol. i. p. 425.

‖ *Course of Lect. on the Physiol. and Pathol. of the Nerv. Cent.*, 1860, p. 185.

¶ Duncan's *Medical Comment.*, vol. iv., cited by Mr. Hamilton in *Dublin Journ. of Med. Science*, vol. xiii. p. 51, 1838.

Dr. Rowland relates several facts which seem to prove that an inflammation in one side of the brain may be caused by an injury to a nerve in the other side of the body.‡ The inflammation of the spinal cord evidently caused by an injury to a nerve in many cases of tetanus, leaves no doubt as regards the possibility of the production of an inflammation of a part of the nervous centres as a consequence of an injury to a nerve. To the cases of inflammation of the brain mentioned by Dr. Rowland, I might add several others, among which the most significant have been recorded by Hennen§ and Meynier.||

Inflammation of the testicle is sometimes produced by a reflex action from an irritated nerve, as in cases by Sir Benjamin Brodie,¶ Barras,** Marrotte,†† and others. Sir Astley Cooper‡‡ says that by irritation morbid actions are excited in distant organs, and adds: "thus inflammation is produced in the testicle from irritation in the urethra."

Inflammation of the abdominal or thoracic viscera may also be produced by a reflex action. Proofs of this assertion are abundantly furnished in Lecture X. of my work on the Central Nervous System. A reflex inflammation may be brought on to such a degree as to cause an ulcer, which nothing can heal until the cause (viz. the irritation of a nerve) is removed. Sir Astley Cooper mentions several cases of that kind.§§

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* *Medical Times and Gazette*, 1857.

† *Des Affections sympath. de l'un des Yeux*, Paris, 1858.

‡ *On the Nature and Treatment of Softening of the Brain*, p. 67, et seq. London, 1851.

§ *Military Surgery*, p. 191.

|| *Gazette Médicale*, decembre 1856.

¶ *Lectures on Local Nervous Diseases*, 1837.

** Cited by Notta, in *Archiv. de Méd.* &c., p. 547, Sept. 1854.

†† *L'Union Médicale*, p. 155, 1851.

‡‡ *Lectures on the Principles and Practice of Surgery*, by F. Tyrrell, vol. i. p. 4, 1824.

§§ Loc. cit. pp. 7, 8.

Muscular atrophy. It would be very easy to show by many facts that this alteration of muscles may be due to a reflex action from an irritated nerve. I have seen several such cases. In one of the most decisive, a man was attacked with a very rapid atrophy of the muscles of the thumb in consequence of a wound of the ulnar nerve. A neuralgia often produces atrophy in neighbouring muscles.* Several of the cases of wasting palsy related in Dr. Roberts' excellent work,† are cases of reflex atrophy. My friend and pupil Dr. C. Bonnefin‡ has seen *nineteen* cases of atrophy caused by a neuralgia.

In a case recorded by Vallez, a wound of the infra-orbital nerve produced an atrophy and a paralysis of the face on the same side, besides considerable alterations in the eye.§

Hypertrophy. This alteration may also be caused by a reflex action from an irritation of a nerve. Several cases of neuralgia, followed by hypertrophy, are mentioned by Notta.‖

Eruptions. Rayer, G. Simon, Delioux, Notta, Romberg, Hasse, Parrot, and others, have frequently seen various kinds of eruptions (*erythema*, *pemphigus*, *urticaria*, and especially the different forms of *herpes*) produced by a reflex action from a nerve attacked with neuralgia. I have also seen several such cases.

Various morbid alterations of nutrition. Two cases of *reflex œdema* after the wound of a nerve are recorded by Mr. J. Hamilton.¶ There are on record several cases of *gangrene*, in which it was impossible to understand how the mortification took place, if it is not through a contraction of blood-vessels by a reflex action. In one of these cases, Dr. Gubler remarks that sciatic pains preceded gangrene of the last phalanx of one of the toes in a young woman in whom there was no appearance of obstruction to the arterial circulation.** *Morbid secretions*, or *cessation of a secretion*, are often the effects of a neuralgia. *Cataract* is sometimes produced by a reflex action from an injury to a nerve.†† It seems probable also that *glaucoma* may be produced in the same way.‡‡

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* See Notta's paper in *Archiv. de Méd.* p. 557, Sept. 1854.

† *An Essay on Wasting Palsy*, London, 1858.

‡ *De l'Atrophie muscul. consécutive aux Névralgies*, Paris, 1860.

§ *Gazette Méd. de Paris*, p. 687, 1847.

‖ Paper in *Archiv. de Méd.* pp. 311, 312, Aug. 1854.

¶ *Dublin Journal of Medical Science*, vol. xiii. pp. 40-42, 1838.

** *Comptes rendus de la Soc. de Biologie*, pour 1854, p. 76.

†† See *Gazette des Hôpitaux*, p. 1, 1846; and *Gazette Méd.* p. 130, 1840; and De Brondeau, loc. cit. *Obs.* xxi. xxii. xxiii. xxiv. pp. 40-46.

‡‡ Tavignot, in *Gaz. Méd. de Paris*, p. 546, 1845.

PART II. GENERAL FEATURES AND RULES OF TREATMENT OF THE VARIOUS AFFECTIONS CAUSED BY AN IRRITATION OF A NERVE.

The following features characterise cases of neuralgia, paralysis, epilepsy, and most other affections depending upon an irritation of a nerve.

1st. Previous to the appearance of the reflex affection, the patient has suffered from a neuralgia, or from pressure upon a nerve, by either a tumour, a displaced bone, or a foreign body, or from a wound or a burn.

2d. An increase or a decrease of the irritation of the altered nerve is often followed, or accompanied, by corresponding changes of the reflex affections.

3d. The various modes of treatment of nervous and other affections, produced by a reflex action, are generally quite unsuccessful, so long as their supposed cause (the irritation of a nerve) persists unabated.

4th. The various affections produced by a reflex action are frequently cured or relieved at once, or very soon after the removal of their cause, viz. the irritation of a nerve.

I may add other characters (more or less implied, however, in the preceding): 1st. That when reflex affections occur by fits, it is not rare to see the fit suddenly produced (completely or incompletely) when the injured nerve is irritated by pressure, or otherwise (application of galvanism, for instance). 2d. That narcotics, applied to the injured nerve, will almost invariably diminish, at least for a time, the reflex affection, unless it consists in, or is connected with, a notable alteration of nutrition.

The above characters will all serve for the diagnosis of reflex affections; but the principal consists certainly in the preëxistence of a lesion of a nerve. It must be remembered that if the trunk of a nerve is inflamed, there may be symptoms only at the terminal ramifications of that nerve; and the only way to ascertain what the starting point is, consists in the examination by pressure of the whole length of the nerve, so far as possible, from the periphery to the brain or spinal cord. If this rule had been applied in the following case, it would not have been published and accepted as a case of reflected influence from a disease of the nerves of the thumb upon the four limbs. Lady —— was attacked suddenly by an acute pain, soon followed by redness and swelling in the left thumb; and the other fingers gradually were also attacked, and afterwards the fore-arm. There was contracture and paralysis, with hyperæsthesia. The other arm became affected in a similar way; and when the pain was violent, there was paraplegia. No benefit was obtained from powerful narcotic applications on the left thumb and hand; but the patient was cured after the use of a counter-irritant ointment, rubbed over the arm.* In this case there had been no injury to the hand; there was no neuralgia; and the symptoms observed in the fingers and the fore-arm were those we find in cases of local meningitis, or inflammation of the sheath of nerves, at their exit from the spine. I have seen two similar cases, both of which were cured by counter-irritants applied to the spine.

The wonderfully powerful and varied influence exerted by an irritation of a nerve is not due to pain, but to a special action, as is well proved by the fact that we see every day cases of pain from neuralgia, or other diseases of nerves, without any remote reflex affection. In few cases that I know was there such an agonising pain as in a patient, in whom a ball had lodged in the trunk of the radial nerve, producing for many days the most excruciating pain, depriving the patient of sleep, and causing a continued perspiration from his face, without any other marked reflex action than a contraction of the fore-arm upon the arm.† In some cases an irritation, producing a grave reflex affection, may start from a nerve without being felt.‡

It may seem quite surprising, and perhaps incredible, that the same cause, viz. an irritation of a nerve, will either produce no effect at all, or produce such a variety of affections as I attribute to such a cause. But those who will take the trouble of studying the variety of effects of a clear cause of reflex action, such as, for instance, the exposition of many people to a cold wind when they come out perspiring from a very warm room, will understand that reflex effects may be very various, although resulting from the same cause.

Treatment. Of the various means of treatment of the remote or reflex effects of the irritation of a nerve, the most important may be classed into two groups—the local and the general means. As regards the local means, they consist chiefly in applications of revulsives or sedatives, or in an amputation or division of a nerve; while the general means consist chiefly in the use of remedies that will diminish the reflex power, or the morbid excitability of the irritated nerve.

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* Case of Pearson, in *Med.-Chir. Trans.* vol. viii. pp. 252 et seq. Pearson does not speak of the spine. Had he examined it, he would have found great tenderness between the shoulders and a little above.

† Case of Denmark, in *Med.-Chir. Trans.*, 1813, vol. iv. p. 48. The patient was cured by the amputation of the arm.

‡ See my *Researches on Epilepsy*, p. 17.

Local means of treatment. Of these means, the best theoretically are also the best according to the mass of facts I have collected. The section of the injured or irritated nerve between the brain or spinal cord, and the part of the nerve which is altered, is certainly the most important local means. I hardly need to say, that if this operation is to be performed, the sooner the better, in cases of hydrophobia, epilepsy, tetanus, reflex neuralgia, paralysis, &c. Of course, if there is any chance of a persistence of the irritating cause, after the time necessary for the reunion of the parts of the divided nerve, an excision of an inch or two, which will retard reunion, must be made instead of a simple division. There is no doubt that in a number of cases (especially those of long duration) this operation will not succeed; and there are many discouraging facts, showing that the alteration of nutrition produced at a remote distance from the irritated nerve will continue after the division of the nerve, owing sometimes to the fact that the nerve is inflamed in a great length between the place of the section and the nervous centres. It would be prudent always to excise at least a small part of the length of the nerve, to ascertain, by a microscopical examination, if it is inflamed at the place of the operation; as, if such is the case, another division ought to be performed much higher up, and even as near the nervous centre as safely possible.

There are cases in which, instead of dividing a nerve, all that is necessary is to gain a few days to allow a wound to heal up. I proposed, several years ago, to make use, in those cases, of a simple means, consisting in laying bare the nerve above the wound, and in dropping sulphuric ether upon it. This operation, especially if repeated, will render the nerve, for many days, quite unable to transmit any irritation from the original wound.

Amputation of a limb should never be resorted to with the view of curing reflex epilepsy, tetanus, &c., unless, of course, this operation happens to be necessary for another purpose.

In hydrophobia, besides the section of the nerve at a notable distance from the wound, it would be prudent to excise the whole length of the nerve from the place of the section to the place of the original wound (*i. e.* the bitten part).

Subcutaneous injections of narcotics just above the wound, or on the irritated nerve, together with applications of emollient and narcotic lotions, or poultices, on the wound itself, are among the best local means after neurotomy. I have seen cases of cure of epilepsy, chorea, irregular attacks of convulsions, and *reflected* neuralgia, cured by subcutaneous injections of narcotics (half a grain of morphia and one-sixtieth of a grain of atropin).

I have derived some benefit also in cases of epilepsy with a distinct peripheric aura, by applications of temporary circular blisters, like a ring, around a limb or a finger.

Applications of ice, or even, sometimes, of a freezing mixture, on the spot where a nerve is wounded or irritated, might be sufficient to produce a cessation of its influence on the nervous centre or another organ. Before dividing a large nerve, this means should be tried.

Applications of the actual cautery (at white heat) may also be very useful; and they are perhaps the best, and one of the least painful counter-irritant means.

I need not say that foreign bodies, tumours (neuromatic and others), or vicious cicatrices, &c., giving rise to reflex affections, should be extirpated.

General means of treatment. The most powerful agents to subdue the reflex excitability of the nervous centres are belladonna, Indian hemp, aconite, ergot of rye, and turpentine. It ought to be remembered that in many cases of reflex affections, the most powerful narcotics, especially opium, are borne in large doses without any poisonous effect. I will not say more as regards the general treatment, as the rules vary according to the kind of reflex affection to be treated.

C. E. BROWN-SÉQUARD.

NEUROMA.

A NEUROMA is a fibrous tumour on, or more rarely between, the fasciculi of a nerve. The size of these tumours varies immensely. In one case, the tumour reached the size of a large melon. Almost always neuromas are purely fibrous tumours.* Sometimes, however, together with purely fibrous elements, neuromas contain those nuclei, and fusiform or caudate, or stellate nucleated cells, which are found in granulations, or in the fibro-cellular tumours.† In some cases also cysts, principally serous, are found in neuromas.

Usually, there is only one tumour; but in some cases there are many, and in several instances almost every nerve was covered with neuromatic tumours. The various branches and the trunk of the great sympathetic nerve are very much less frequently attacked with neuroma than the cranial or spinal nerves.

The usual shape of a neuroma is that of an olive, the long diameter being in the direction of the nerve. There is no adhesion of the tumour with the neighbouring tissues, no tortuous or dilated veins round it, unless it is extremely large; and the tumour is generally firm and elastic, and of a slow growth.

The nerve-tissue is not destroyed by the development of a neuroma; on the contrary, it seems that sometimes new nerve-fibres are formed in the tumour. As a general rule, neuromas develop themselves on one side of a nerve.

The symptoms of a neuroma consist in attacks of pain, darting almost only towards the periphery of the nerve, except in cases due to a wound, in which the pain very often radiates upwards and extends to other nerves by a reflex action. Generally the pain recurs by paroxysms, followed either by its complete cessation, or at least a great diminution of its intensity. Sometimes there is no pain, except on pressure upon the neuroma. As a general rule, such a pressure causes much pain, and sometimes the least touch cannot be tolerated. In other cases, although there is much pain more or less constantly complained of, there is no tenderness on pressure of the neuroma: those are cases of pure neuralgia. The cystic and the traumatic neuromas generally cause much more pain than the idiopathic and purely fibrous neuromas. As a general rule, multiple neuromas do not cause pain. When an examination of a tender neuromatic tumour is to be made, pressure upon the diseased nerve above the tumour should be made, to destroy sensibility in the parts to be examined.

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* See the description of fibrous tumours, by Mr. Paget, in this work, vol. i. p. 483.

† Paget, loc. cit. p. 480. Several cases of this kind have recently been published by Dr. Hitchcock, *American Journal of Med. Sciences*, April 1862, p. 320; and one by R. Volkmann, *Brit. and Foreign Med.-Chir. Rev.*, April 1859, p. 513.

The symptoms produced by the influence of a neuroma upon the nervous centres and other organs are extremely variable. Chorea, epilepsy, hysterical symptoms, trembling, reflected neuralgia, anæsthesia or paralysis, and many other affections, have been observed as effects of the irritation of a nerve by a neuroma as well as by any other lesion of a nerve (see the essay on DISEASES OF NERVES).

As regards the peripheric effects of a neuroma, it is very remarkable that there is not often a considerable paralysis of sensibility or movement. Generally there is not more than numbness, and a very slight paralysis.

The causes of idiopathic neuroma are not known. Dr. Robert W. Smith, in his complete monograph on this subject,* clearly shows that neither neuritis nor rheumatism are ordinary causes of neuroma.

There is no other treatment for neuroma than extirpation of the tumour or amputation, if, as in a case of Chelius, the first operation is not possible. After extirpation, the patients have a great chance of recovering sensibility and movement in the parts which receive branches of the excised nerve, in consequence of the reunion of the divided ends, or rather of the regeneration of a part of the excised nerve. There are many cases showing, that after excision of one or several inches of the ulnar, median, radial, posterior tibial, and even sciatic nerves, reunion or regeneration have taken place, and sensibility and movement have been recovered. However, when possible (and it is not rarely so), the tumour should be dissected and extirpated without dividing the trunk of the nerve. Except in cases of fibro-plastic or fibro-cellular neuromas, there is no danger of the reproduction of the tumour after extirpation.

C. E. BROWN-SÉQUARD.

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* *A Treatise on the Pathology, Diagnosis, and Treatment of Neuroma*, Dublin, 1849, folio.

DISEASES OF THE TONGUE.

THE tongue, an organ of well-known form, to which the sense of taste is chiefly referred, is composed of muscular and of gland-substance, covered by mucous membrane, continuous with that of the mouth and fauces. The more delicate appreciation of taste is limited to the upper surface, where the papillæ of the mucous membrane are remarkably developed. The proper muscular structure is striated, and arranged in two horizontal and many vertical layers; the former, immediately subjacent to the mucous membrane, are to be found on the upper and under surfaces; the latter pass vertically from one horizontal layer to the other, connecting them, but leaving intervals, which are occupied by gland-structures, supplied by ducts opening on the under surface, and secreting a fluid resembling saliva. In the posterior third, the muscular prevails over the gland-structure, which is reduced to two large lateral bodies. Abundantly supplied with nerves and blood-vessels, always in movement, and exposed to many sources of irritation or injury, this organ often becomes the seat of disease.

I know of no well-authenticated instance of atrophy of the tongue, nor of congenital tongue-tie, so as seriously to interfere with the movement of the organ. The frænum, it is true, extends in some cases to the tip of the tongue, when its division may be easily accomplished; but the defect usually produces little or no inconvenience, and the difficulty of utterance with which it is frequently associated proceeds from causes affecting the sensorium. Still the division of the frænum linguæ is an operation somewhat popular, and may be performed without detriment to the patient.

Hypertrophy and enlargement of the tongue ("lingua vituli, lingua propendula, macro-glossia," &c.) is an affection occasionally seen. The references collected by Dr. Humphry on the subject point to the probably congenital nature of this deformity. Zacchias* relates that he saw at Rome, in 1628, a male infant well made, except that the tongue projected three fingers' breadth from the mouth. The child could suck, and lived to the age of fourteen months, when it died without obvious cause. Bertholin* mentions a case of "linguæ portentosa magnitudo," related to him by his pupil Bagdun: a male child, born with the tongue out of the mouth as large as a filbert. As the child grew, the tongue increased to the size of a calf's heart. Sauvages, in his *Nosologia*, speaks of enlargement of the tongue in new-born infants. Percy and Laurent† speak of two cases: one a woman, in whom the enlargement was dated from birth, but rapid increase took place at the age of three. The other was that of a boy, aged sixteen, whose tongue hung three inches below the chin, was two inches and a half thick, and filled the mouth. The affection had existed from birth. In Mirault's case, the man, aged thirty-four, had suffered from infancy; so likewise in that related by M. Maurant.‡ In other cases the enlargement is described as commencing in the first or second years, when perhaps the better expression would have been, "was then first noticed;" for the tongue is an organ in which hypertrophy in a slight degree might be readily overlooked, especially in early life, and before attempts are made at articulation. In a few other cases the beginning of the swelling in adults has been referred to salivation. I am inclined, then, to the belief that hypertrophy of the tongue as seen in infancy is congenital.

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* *Quæst. Med.-leg.* lib. vii. tit. 1. quæst. 9.

The measurement of the tongue in the case of a child of eleven, under the care of Dr. Humphry,§ was as follows: from the upper lip to its tip, $3\frac{1}{2}$ inches; from the under lip to its tip, $1\frac{1}{2}$ inch; from the angle of the mouth round the sides and tip to the opposite angle, $6\frac{1}{4}$ inches. The circumference of the widest part, which was about the middle of the protruded portion, measured $6\frac{1}{2}$ inches circular measurement; immediately within the lips, 5 inches. When drawn into the mouth to the utmost possible extent, the tongue measured from the upper lip to its tip 2 inches. The organ was soft and supple, having been kept habitually covered in a bag hung from the head. The papillæ were greatly enlarged, and separated by deep clefts, giving to the exterior of the mass a coarsely granular or warty appearance. The colour of the organ was natural. The opening of the mouth was large; the lower lip everted, and the angles of the mouth depressed, so as to elongate and give a peculiar expression to the face. The orifices of the sublingual ducts, of

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[*] *Hist. Centur.* iii. p. 85.

[†] *Dict. des Sc. Méd.* vol. xxvii.

[‡] *Journ. de Méd.* vol. xv.

[§] *Med.-Chir. Trans.* vol. xxxvi. p. 114.

unusual size, were situated just in front of the edge of the lip; the saliva was continually dribbling from the end of the tongue, the quantity thus lost amounting during the day to more than half a pint. Owing to the constant pressure of the tongue on the mental portion of the lower jaw, a curvature had taken place in that bone just in front of the masseter muscles, in such a manner that a wide interval always existed between the incisors and bicuspids of the two jaws. Even when the mouth was closed, that is to say, when the corresponding molar teeth were in contact, this interval between the incisors measured nearly two inches, being increased by the horizontal direction which the inferior incisors and the alveolar process of the lower jaw had assumed. These were so placed as to form a wide channel, in which the tongue rested.

Dr. Humphry determined to remove the protruding part of the tongue by excision, although he was aware that a fatal case had occurred elsewhere from this practice.* He passed a straight bistoury from below upwards through the organ a little to the left of the middle line, and cutting forwards and outwards formed a left lateral flap. He then secured a vessel. Next he cut across the middle of the tongue, dividing the ranine arteries, the movements of the organ being still controlled by means of the prolapsing portion, which was not quite severed. The operation was completed by the formation of an oblique lateral flap on the right side, corresponding with that on the left. The flaps were approximated so as to form a tip, and maintained in apposition by two sutures passing deeply. The hæmorrhage was not very great, and the bleeding vessels were tied without difficulty. A good deal of swelling of the tongue followed the operation; but under frequent washing and fomentation it soon subsided, and the wound healed. At first the lips could not be approximated, and the thick stump of a tongue was always visible, though never protruding. After a few days, however, by continued action of the orbicularis muscle, the mouth was closed. An apparatus was then constructed to act by pressure on the deformed jaw, and ultimately a result was obtained highly creditable to the operator.

The effect of continued pressure on the enlarged tongue is a mode of treatment only applicable to early cases, and is uncertain in its results. In a case under the care of the late Mr. Crosse, the swelling, partly removed by this method of treatment, soon returned, and the relief appears to have been imperfect. Sir Astley Cooper treated such a case by ligature; but to this proceeding an objection offers itself in the formation of a slough occupying the anterior part of the mouth, and in the immediate proximity of the nostrils. The écraseur is an instrument generally unsuited to operations about the mouth, fauces, or tongue; but may be advantageously used whenever there is fear of uncontrollable hæmorrhage.

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* A girl, aged fourteen, in whom the enlarged tongue hung out of the mouth three inches, was under the care of Mr. Syme, who removed the prolapsing part by oblique incisions meeting at an angle in the centre of the tongue, and united in the middle line by sutures. The child died a few days after, from inflammation and swelling of the tongue and parts about the larynx.

Acute inflammation of the tongue, attended with sudden enlargement, is a disease occasionally seen. Mr. S. Cooper remarks that it may arise spontaneously, and without any apparent cause; or else from some particular irritation, such as that of mercury or some poisonous substance.* He mentions that, in the middle of the seventeenth century, Schlegel, who was at Paris, saw a patient in salivation, whose tongue became so enormously enlarged that the mouth could not contain it. Pimprenelle, an eminent Surgeon of the time, was sent for, and amputated one half of the organ; a measure which Louis justly criticises as extremely violent.

The disease to which I now refer, however, proceeds from occult atmospheric causes. The swelling is sudden, perhaps occurring during the course of the night, and it produces feelings of threatened suffocation, having been preceded by loss of appetite and a general sensation of *malaise* for a few days. The first case which came before my notice was that of a gentleman aged sixty, of remarkably abstemious habits, living chiefly on vegetable diet; the second, that of a young married lady, residing in lodgings in a healthy part of London. In this latter case the swelling of the tongue was so great that the mouth could not be closed; the teeth became coated with sordes, and a profuse watery and highly fœtid discharge flowed without intermission for many days. The patient feared to close her eyes in sleep; and so difficult was the respiration, that at one time the question presented itself, whether it might not be necessary to make deep incisions into the swollen organ, or even to open the trachea. However, by constant attention to cleanliness and gargling, by the local use of ice, by supporting the strength with wine and quinine, and the administration of nourishment by enemata during a short time when deglutition was impossible, the swelling subsided, and the patient recovered. For some weeks, however, she remained in an enfeebled state. I saw about the same time two other cases in St. Bartholomew's Hospital. In both the disease was rapid in its course, the accession lasting but a few hours, and the swelling usually subsiding within a week.

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* *Surg. Dict.*, ed. 1830, p. 1102.

But during the period of acute œdema of the tongue, the patient may die suffocated; and the Surgeon should bear in mind that such an accident may be prevented by his making free and deep longitudinal incisions into the swollen organ. "I have seen a patient," observes Mr. Erichsen, "who was nearly suffocated by the immense size of his tongue, relieved at once, and get nearly well in the course of a few hours, by such incisions."* These incisions should be made along the upper, rather than the under surface of the tongue, that the ranine artery be not wounded; and there is but one caution; the œdema may so far involve only one side of the tongue as to cause the lower surface, which yields the more readily, to be turned *directly upwards*, in which case the incision made above passes in truth into the tissues normally inferior. Such a case happened in the practice of Mr. Wormald, who found that, upon the subsidence of the swelling, the incision made above gradually acquired a directly inferior position.

I have not known tracheotomy necessary in such a case, although the symptoms might possibly be such as to demand it. The condition of the mouth prevents the administration of medicines during the acute stage. Afterwards we must be guided in the selection of remedies by the state of the pulse. Should there be much fever, saline and diaphoretic remedies are suitable. But more commonly the indication is to support the strength, by the administration of tonics, wine, and nutritious diet. For the mouth, a gargle containing alum, or borax and honey, or tincture of myrrh, may be used; and the Surgeon may give much relief by carefully wiping away the thick viscid secretion from the teeth, and by touching any ulcerated spots with a weak solution of nitrate of silver.

In the museum of Guy's Hospital there is a preparation of a portion of a tongue, weighing two ounces and three drachms, removed by ligature by the late Sir Astley Cooper, in consequence of enlargement following salivation produced by mercurial medicines in the treatment of syphilis. And another preparation (1672) illustrates the extreme effects of mercury, namely, mortification of the organ; a result extremely rare, and due to the injudicious and long-continued administration of this powerful agent.

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* *Science and Art of Surgery*, 3d ed. p. 804.

Abscess. I have seen very few cases of abscess of the tongue. One case was that of a lady of middle age under the care of Mr. Stanley. She had a firm tumour, the size of a large pea, imbedded in the substance of the tongue. Considering the patient's age, and the symptoms attending the formation of the tumour, Mr. Stanley could not dismiss from his mind the idea of carcinoma. But its situation in the middle of the substance of the organ militated against that idea. He made an incision into the mass, and a small quantity of healthy pus escaped. The wound cicatrised, and the lady has continued in good health for many years since. Mr. Erichsen* says, "abscess of the tongue, though rare, occasionally occurs. A boy was brought to me some time ago with an elastic fluctuating tumour of slow growth and about the size of a small plum, situated deeply in the centre of the tongue. On puncturing it, about half an ounce of healthy pus was let out, after which the cyst speedily closed." Other similar cases are met with scattered through medical literature, and they show that the gland-follicles of the tongue are liable to suppuration.

Chronic ulceration. "The most frequent forms of disease in the tongue," observes Mr. Lawrence,† "are, ulceration, generally superficial, sometimes more deeply seated; swelling and thickening of the mucous membrane; swelling and induration of the substance of the organ. Ulceration often exists in conjunction with swelling of the mucous membrane and with induration of the lingual substance. The more formidable diseases of the tongue are syphilitic or cancerous; the former being by far the most numerous. Disorder of the digestive organs is sometimes the source of the mischief, giving rise to affections which are usually superficial, but sometimes of more serious character. When maintained by imprudent indulgence in drinking, there is often a sore state of the organ, the epithelium being smooth, reddened, or white and opaque. When the surface is superficially ulcerated, the ulcerations are generally small, circular, and of grayish colour; occasionally there is thickening of the mucous membrane, and deeper ulceration." In the same volume of the *Medical Gazette* (p. 800), Mr. Lawrence relates some cases in illustration of these points. A healthy-looking gentleman, between forty and fifty, who had always enjoyed excellent health, but who had lived freely, became the subject of the following condition of the tongue:—the mucous membrane over the greater part of the organ was unnaturally smooth, more or less opaque and white, here and there raw, as if it had been ulcerated. It had been in this state, generally causing great pain, for four or five years. Under a course of mild mercurial medicines, the employment of tincture of myrrh as a gargle, and abstinence from strong drink, the pain ceased in a week; and the general condition of the tongue was improved, although the surface remained smooth and white, but otherwise sound.

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* *Science and Art of Surgery*, 1853, p. 673.

† Clinical Lecture reported by Mr. Coote, *Med. Gazette*, 1845, p. 703.

A lady, between fifty and sixty, of unhealthy appearance and with a red pimply face, who had often suffered from disorder of the digestive organs, consulted the same Surgeon for a disease of the tongue of formidable appearance. The middle and upper part of the organ was swollen, and occupied by a deep ulcer of irregular figure and foul aspect. It was very painful, interfering with mastication and articulation. The digestive organs were much disturbed. The complaint yielded speedily and effectually to simple measures, regulation of diet and the digestive organs, small doses of extract of henbane, and soothing local remedies. Some years ago a patient, about fifty years old, came from the country to consult Mr. Lawrence. The man was of sallow aspect, and had lived freely. On the upper surface of the tongue, in a space about an inch and a half long by an inch wide, the mucous membrane was thickened, indurated, and raised into irregular prominences, which were smooth and not ulcerated. The complaint had existed some months, having become so painful that he could hardly take food; washes and gargles had been of no benefit. There was no suspicion of syphilis in this case; and the habit of drinking, especially spirits, sufficiently accounted for the disease. Mr. Lawrence prescribed the compound decoction of sarsaparilla with compound decoction of aloes three times a day, four grains of the extract of hyoscyamus at night, and a strictly regulated diet. When again seen at the end of a fortnight, all the pain had ceased, and he could masticate any thing. He considered himself well, and returned to the country. I saw a tall, spare-looking man, aged sixty, March 18th, 1860, in whom the gums had shrunk from the teeth, leaving the roots denuded to the alveolar border, and exposing them to an accumulation of tartar. The patient had lived freely, having been a publican. The whole of the tongue was swollen, smooth, and of glistening red hue.

There was no trace of the papillæ, except at the base, where the papillæ circumvallatæ appeared hypertrophied. In those situations where the organ rubbed against the exposed and roughened teeth, the mucous membrane was white and thickened, and seemed to surround numerous small and unhealthy-looking ulcerations. I directed this patient to have the teeth examined and cleaned by a competent dentist; imposed a strictly regulated diet, ordered a gargle containing alum, and occasional aloetic aperients. Considerable improvement took place; but after a time the patient declined to attend to the strict regimen which was considered necessary.

This smooth glazed condition of the tongue differs from that commonly seen in persons suffering from chronic dyspepsia, though habitually abstemious. In these latter cases, the mucous membrane has a red, uneven, and raw aspect; it is deeply fissured, ulcerated in spots; the papillæ may be universally or partially hypertrophied, or portions may acquire between the fissures a "knobbed" aspect. It is important to distinguish these different affections, and to trace the morbid changes to their proper cause. Above all, it is necessary to distinguish them at the earliest stage from those more serious affections, syphilis or cancer. The former appears in a variety of forms, and under circumstances perhaps unexpected. The latter, more definite in its symptoms, is, however, often masked at its commencement by circumstances which will demand all the Surgeon's accuracy of diagnosis. Induration of the tongue is said to be of syphilitic nature when it occurs in the centre of the organ, and to be of cancerous nature when it commences at the margin. And this is generally true; but yet there may be an indurated condition of the tongue neither malignant nor syphilitic. A hatter, aged sixty-one, of unimpaired constitution, who had never had syphilis since the age of eighteen, found that whenever he had been exposed to the fumes of some secret composition used in his trade, the tongue became sore, cracked, and dry, and remained so two or three days. For the last three years it had swelled and become painful during the winter months, but returned to its natural state with the approach of warm weather. About four months before he was seen, the back part and left side of the tongue swelled up in an unusual manner, and became hard. This was attended with a dull aching pain. The surface was uneven and tuberculated, and presented several superficial ulcerations not extending beyond the mucous membrane. The hardness resembled that of scirrhus. The absorbent glands under the jaw were not affected. Iodide of potassium was tried without effect. A course of mercury was next administered, under which the gums became sore, and the organ recovered so much of its normal character that the patient was pronounced convalescent.

Nævus of the tongue. On March 15th, 1852, I saw a private patient under the care of Mr. Lawrence, suffering from congenital venous swelling involving the right border of the tongue. The part had a livid-blue colour, with rounded and irregular surface, marked by large tortuous veins. Mr. Lawrence made an incision into it, and evacuated a quantity of fluid venous blood, by which the bulk of the tumour entirely disappeared. A ligature was then applied to arrest the hæmorrhage, when there was renewal of the swelling to even a greater extent than before. The venous trunks still communicated one with another. Ultimately the case did well. A student at St. Bartholomew's Hospital showed me in 1853, on his own person, a large congenital venous nævus of the tongue, occupying its right half, including both upper and under surface. At one time it used to bleed; but it had long ceased to cause him inconvenience, and had been stationary for many years. Bearing in mind the fact that nævi may first become stationary during the growth of the body, and ultimately disappear, I recommended this gentleman to let the disease take its course; and I was strengthened in this opinion by the remembrance of an examination made of a similar nævus removed by Mr. Lawrence from the anterior part of the abdomen of a young gentleman of about twenty, in whom it was found that the venous swellings were undergoing a process of atheromatous or fatty degeneration, and that no further enlargement was, under ordinary circumstances, to be feared.

There is difficulty in the treatment of such an affection if the growth can be neither tied with a ligature nor extirpated by the knife. An organ so movable and highly sensitive as the tongue does not well bear the application of powerful caustics in any form ; and proceedings which are practicable in other parts of the body are here counter-indicated, both on account of the œdema to which they may give rise, and the subsequent pain and difficulty of deglutition. Fortunately, nævi of the tongue are uncommon, and do not usually acquire great magnitude. When extirpation is thought right, the Surgeon may remember that the hæmorrhage, though profuse, may be generally controlled by ice. When the ligature is to be applied, it is usually introduced by a strong curved needle; the tongue being drawn forward by an assistant, who holds the organ, covered at the front part by a towel, between the thumb and fore-finger of the right hand. No instrument can press and hold the tongue with the same certainty as the human hand.

On May 17th, 1847, Mr. Lawrence removed a small vascular tumour of the tongue from a young lady aged 19. She had previously had removed a vascular tumour from the gum of the lower jaw opposite the incisor teeth, one of which had been extracted. On microscopical examination of the extirpated parts, I found that the papillæ of the tongue, about the centre of the tumour, were hypertrophied and agglutinated into a prominent and flat-surfaced mass of whitish colour. It was composed of white fibrous tissue, of stringy, fibrous matter, and of an immense quantity of mucus and of epithelial cells. It seemed, upon section, as if the follicular portion of the mucous membrane was much enlarged and hypertrophied, and covered by altered and thickened papillæ.

Mr. Paget says, "In the museum of the Middlesex Hospital is a fatty tumour, one and a half inches long, which was removed from beneath the tongue, where it looked like a ranula; and in the College museum, No. 190, is one taken from the substance of the tongue." This Surgeon also states that he removed an oval bilobed tumour, about half an inch in diameter, from the tongue of a young man, from the substance of which, near its apex, it had been growing for three years. It was firmer than most others of a similar kind, yet succulent, and formed of an obscurely filamentous tissue, abundantly nucleated.*

Ranula is a fluctuating, semitransparent, livid-blue swelling, situated under the tongue, and is commonly described as a dilatation of the duct of the submaxillary gland (Wharton's duct). Doubts are now entertained by many authors of the accuracy of this description, and Mr. Erichsen questions how so small a duct can be dilated to so large a size as is occasionally attained by these tumours. This doubt, however, disappears when one reflects upon the enormous size which the minute ducts of the mammary gland may attain in serocystic sarcoma. In one case of ranula under the care of Mr. Lawrence, the little finger could be inserted for a short distance into a cylindrical tube, pursuing the normal course towards the gland. And in another case under my care, the patient, a domestic servant, presented herself with a hard swelling near the frænum linguæ, which had been pronounced "a cancer." Upon examination, I detected in Wharton's duct one of those phosphatic concretions, about the size of a pea, common to the ducts of the salivary glands; it was removed with ease, and the patient recovered in a few days. But cysts may form in the floor of the mouth from any of the causes which lead to the development of cysts in other parts of the body. Many years ago Mr. Lawrence requested me to give him assistance in the following operation. A young lady had a swelling on the floor of the mouth. It was firmer and more solid than the common ranula. Mr. Lawrence made an incision through the mucous membrane, and endeavoured to extirpate the cyst entire; but finding it too large, he made an incision into it, and, with the handle of the scalpel, took out a quantity of thick matter, the consistence of putty. He then removed the entire cyst, which was but loosely attached to the surrounding parts. The patient recovered. Then we meet with other cases in which a cyst, containing a fluid of watery consistence, extends from the floor of the mouth under the sterno-mastoid muscle to the middle of the neck. Such a tumour can scarcely be regarded as an enlargement of Wharton's duct. The proper conclusion seems to be, that cysts may form in this situation from four sources. First, dilatation of Wharton's duct. Secondly, dilatation of one of the sublingual ducts. Thirdly, dilatation of a mucous follicle. Fourthly, dilatation of a bursa mucosa, said to exist on the outer surface of the geniohyoglossus muscle. The contents of a dilated Wharton's duct are a perfectly clear and thick albuminous fluid of the consistence of white-of-egg; occasionally we meet with phosphatic concretions. An enlarged mucous follicle is filled with a putty-like substance consisting of epithelial cells filled with granular fat. An enlarged bursa, which may extend down the neck, contains a clear serous fluid, in which blood-discs may be from time to time detected in various quantities. I have no information respecting dilatation of the sublingual ducts.

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* *Surg. Path.* vol. ii. pp. 98, 110.

The mode of treatment varies in these different forms. In the first case, the most prominent part should be seized with a pair of sharp-pointed forceps, and cut away with scissors. The interior may then be rubbed with nitrate of silver. The duct will contract to its normal size. In cases of cysts containing putty-like matter, the cyst, which is generally but loosely attached, should be dissected out entire. And in the case of the enlarged bursa, the fluid may be evacuated by a trocar, and a solution of iodine then injected; or the cyst may be traversed by a seton, so as to excite inflammation, and its subsequent obliteration. Mr. Skey employs a single silken thread passed through the floor of the mouth to the most depending part of the cyst; and I have seen benefit result from this treatment.

The tongue is subject to injuries of various kinds; the most common of which are those inflicted by the teeth in the convulsive fits of epilepsy. There are instances known where a portion of the organ has been completely severed by the spasmodic closure of the mouth; but the injury is rarely of a nature to require a suture. Wounds heal very readily; and a foreign body, however small, is irritating to the mouth. But a suture may, if necessary, be applied. In the museum of Guy's Hospital there is a specimen (1674) showing a piece of tobacco-pipe embedded in the substance of the tongue; the soft parts had closed over it, so that its presence was not readily detected during life. Frequent hæmorrhages ensued; and the case proved ultimately fatal. Fatal hæmorrhage rarely occurs from a simple wound of the tongue. The bleeding generally ceases upon the application of ice.

Ligature of the lingual artery above the great cornu of the os hyoides in the neck, for the purpose of controlling hæmorrhage from the ranine artery, is recommended, but is rarely required.

Syphilitic affections of the tongue are mostly ulcerative, and combined with secondary symptoms in other parts of the body. The most common sequence of symptoms is an indurated primary chancre, followed by glandular enlargement in the groin, syphilitic lepra, ulceration of the tonsils, soft palate and tongue, and iritis. But ulceration of the tongue, as well as the other forms of constitutional syphilis, may follow any variety of primary sore. Syphilitic induration of the tongue may occur alone, in which case it has been mistaken for cancer. But the following rule generally holds good for diagnosis when taken with other points. Syphilitic induration commences in the middle, cancerous induration on the border or edge of the tongue. The diagnosis, however, is not always easy. A female, aged thirty, servant in a family of respectability, presented herself at the hospital, with a foul ulcer of the tongue on a hard base, situated between the middle line and the edge of the organ, midway between the base and the apex. It had existed three months; there were no other symptoms. After due consideration, it was thought that the disease was syphilitic; and she was put upon the proper remedies, namely, two grains and a half of mercury and chalk three times a day, when the ulcer healed, and the induration disappeared. We then learned that the patient had suffered from syphilis, under peculiar circumstances, which it is unnecessary here to relate. A gentleman, æt. forty-five, consulted Mr. Lawrence with an indurated knot the size of a sixpence on the middle of the dorsum of the tongue. It had resisted common treatment, but yielded to a slight mercurial course. No other constitutional symptom of syphilis was present, and the primary sore, which was little more than an excoriation, had happened eight months before. From the upper surface of the tongue there may project a mass of hypertrophied epithelium, which, blended together, constitutes a mass analogous to the mucous tubercle commonly seen about the scrotum, the vulva, or anus. For the treatment of these syphilitic affections the reader is referred to the essays on the diseases of those organs.

Cancer, as it affects the tongue, usually occurs in one of two forms: either interstitial deposit, when it is called scirrhus; or more superficial development, when it is called epithelial cancer, or epithelioma. Both forms are of serious nature. I have not hitherto known any well-recognised case in which, even after the most complete and early removal, the cure has been permanent. In both instances microscopic investigation detects the usual elements of cancer, namely, nucleated cells and connecting tissue.

We have first to inquire what is the cause of cancer of the tongue. Is it due to local irritation, such as is excited by an irregular or broken tooth? If such were the case, how infinitely more common should it be! how frequently should we notice its ravages in the mouth! Many experienced dental Surgeons deny that irregularities in the shape of the teeth will do more than determine the exact seat of development of cancer in constitutions previously so disposed; and the same may be said of the irritation excited in other ways. Let us take, for example, the irritation produced by a clay-pipe. How many are there who smoke unaffected by cancerous disease to the end of a long life! How often have we to remove carcinomatous or cancerous growths from the mouths of persons who have rarely or even never smoked at all! I lately extirpated such a tumour from an aged man of seventy. He had lived a most abstemious life, and had rarely indulged in any luxury, however humble. The wound of the tongue cicatrised; but the patient died eight months afterwards of secondary disease in the glands of the neck. Still the irritation excited by the constant presence of a tobacco-pipe cannot be ignored. In 1848 I examined the body of Major-Gen. D., æt. sixty-three, a patient under the care of Mr. Lawrence, who gave me the following history of the case. This officer had been above thirty years in India, where he had lived freely. He was always in the habit of smoking a short clay-pipe, the end of which he kept firmly wedged between the floor of the mouth and the under surface of the tongue. About July 1847, he noticed a slight impediment to swallowing; the food, as he said, was caught in its passage through the fauces. A physician applied caustic, but without avail; the disease increased, and the left side of the tongue became swelled and hard. The patient died June 19th, 1848, without particular suffering, and rather from exhaustion than from suffocation. On examination after death, a deep ulcer was found, the size of a shilling, with red and raised edges, on the left side of the under surface of the tongue. It perforated the root of the organ, and spread on the dorsum into an ulcer three inches broad and two inches from before backwards, in which direction it involved the soft palate and tonsils, and had destroyed the epiglottis and the aryteno-epiglottidean folds. The aperture of the glottis was nearly blocked up, and disease spread into the interior of the larynx. There had been little or no hæmorrhage during life. There were six or seven small absorbent glands, infiltrated by masses of opaque yellowish-white matter. The morbid growth consisted of epithelial cells, and similar bodies were imbedded in the tongue along the course of the penetrating ulcer. This gentleman's father had lived to a very advanced age.

Hard cancer or scirrhus of the tongue commences as a firm and incompressible knob on the edge of the organ, situate often opposite the last molar or wisdom tooth; or so far towards the root that it is beyond the reach of surgical interference. The patient at first complains that the tongue is sore, and he often attributes this symptom to the irritation of an unsound tooth, and the uncontrolled movements of the jaw during sleep. Soon the act of deglutition becomes painful; the patient fears either to eat or drink; a sharp pain extends along the Eustachian tube towards the ear; the saliva flows from the mouth profusely. The symptoms become aggravated during sleep; the nights are disturbed by the secretion accumulating in the throat and exciting cough. Often the patient is roused by a painful compression of the tongue between the jaws; and as the ulceration extends, hæmorrhages occasionally supervene. Sooner or later the sub-maxillary absorbent glands become enlarged by the same cancerous deposit, when first a circumscribed and then a diffused tumour forms in the neck, covered by thin and reddened integument, which, should the patient survive a sufficient length of time, ulcerates, leaving a foul open sore, discharging a thin fœtid fluid, with occasional hæmorrhages. But with the progress of the disease emaciation supervenes, and the patient dies with the usual cachectic indications of cancer.

But this is not the only form of malignant disease affecting the tongue. In 1847, Mr. Ceely of Aylesbury removed from the tongue of a patient a soft, friable, and irregularly-lobulated mass of reddish-brown colour, with vascular red points, but without any distinct arrangement of vessels, composed of caudate or club-shaped cells with large nuclei, blood-discs, and a thickish matter coagulable in alcohol. The tumour, said Mr. Ceely, when examining it immediately before its removal, protruded from the mouth; the tongue was thrust to the left side, and was swollen; the lips were œdematous; the surface of the tumour was in many places black, and a sero-sanguineous fluid oozed from its upper part. By retracting the angles of the mouth, and directing the patient to thrust the tongue forward, and at the same time raising the tumour over the lower lip, it was brought so far forward as to become girt round its broad base by the whole circumference of the mouth, where it remained fixed. It then felt quite elastic, and measured longitudinally five inches, transversely three inches. While it was in the above situation, I placed my fingers, continued Mr. Ceely, under the tumour, and gently raising it from the base I peeled it off, when a large jagged surface was left, which was soon covered with coagula from bleeding vessels. The hæmorrhage was moderate, and easily repressed with the matico-leaf in coarse powder. The portion removed very much resembled recently detached placenta, though perhaps less firm; it was a spongy, granular mass, with interstitial fluid blood; it had none of the shaggy filamentous appearance of cauliflower excrescence detached from the uterus. The weight of the mass removed was seventeen drachms and a half. On April 8th, 1860, Mr. Ceely reported that the man was still alive, although the morbid growth was reproduced within a week.

I saw near to Town, in 1848, a patient in whom there was scarcely any vestige of tongue remaining, the whole organ having been affected with a similar friable degeneration. The patient could still articulate, and suffered less than might have been expected.

In 1860, a patient under the care of Mr. Harle, Surgeon, of Islington, presented himself at the hospital, in whom a portion of the upper surface of the tongue, the size of a sixpenny-piece, was occupied by an opaque white layer or mass, consisting of thickened epithelium, rising above the level of the surrounding parts. Under the microscope the substance was seen to consist of epithelial scales, dried and deformed, and containing but few nuclei. There was no tendency to indefinite propagation, as in cancer, nor to any complication of the neighbouring tissues. The papillæ under the white mass seemed enlarged. There was no swelling of the neighbouring absorbent glands. The disease had existed twelve years without material change; the patient was a healthy woman aged forty, and no surgical interference was indicated. But when this white mass was raised, and the state of the papillæ seen beneath, the resemblance to epithelioma was obvious. And it was found, by microscopic examination, that the softer epithelial cells carried out this resemblance further. That the disease was not of cancerous nature was proved by the history; no source of local irritation was discovered by the most careful examination; and the case served to illustrate the fact, that in malignant disease there is something beyond the mere increase of the epithelial elements. It was in all probability of this character that a tumour, called supposed epithelioma of the tongue, partook, which was presented to the Pathological Society, December 6th, 1859.* It was taken from a patient aged seventy-nine; had existed sixteen years, and had been six years under observation. It involved the tip, the right half and the left side of the tongue; the pharynx and larynx were atrophied. After death, an examination of the body was made, when no malignant disease was found elsewhere. In 1857, I saw a similar case under the care of Mr. Ceely of Aylesbury. The patient was a sailor, of very intemperate habits; and about fifteen years ago he presented himself with a small epithelial growth on the tongue about the size of an almond.

A cancerous tumour of the tongue should be extirpated, when possible, by the knife. The patient must sit in a chair, with the head supported: chloroform had better not be given in simple cases, because the concurrence of the patient is needed. An assistant grasps the tip of the tongue, covered with a towel, between the fore-finger and thumb of one hand, while with the other he pulls back the cheek. The Surgeon then seizes the tumour *completely* within the blades of double-hooked forceps, and with a sharp round-pointed knife, of somewhat large size, sweeps away the enclosed mass in a few seconds. The whole tumour must be grasped with the forceps, that none be left behind. The hæmorrhage renders any subsequent examination troublesome. The knife should be round-pointed, that none of the arteries on the floor of the mouth be wounded. It may be curved in different ways, according to the fancy of the operator; but a straight knife is always the best. The hæmorrhage must be controlled by ice. An artery which commonly needs a ligature is the sublingual; and this can only be wounded by the Surgeon using a sharp-pointed knife. No ligatures or sutures are usually desirable to the wounded tongue; they irritate the mouth, and excite the flow of saliva. The cut surfaces granulate and heal, leaving perhaps an elevation of the substance of the tongue, from its being puckered up at the seat of operation. This, however, can be distinguished from the reproduction of disease by the absence of induration.

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* *Path. Soc. Trans.* vol. xi. p. 240.

The écraseur has supporters as a proper instrument for the performance of these operations. When both lingual arteries may be divided, it is to be preferred to the knife. But I cannot recommend entirely the proceedings of M. Chassaignac. This Surgeon amputated the tongue close to its base, in consequence of cancer of that organ, by means of the écraseur. As the disease threatened to involve the entire organ, its complete extirpation was resolved on. Two or three days before undertaking the operation, M. Chassaignac passed a drainage-tube from without round about the base of the tongue, immediately above the great cornu of the os hyoides. The point where the tube was introduced was a little to the right of the middle line. Having thus prepared a passage for the chain of the écraseur, the tube was withdrawn as soon as the chain was in position. Then commenced the separation of the organ. Two minutes were allowed to elapse between each movement of the instrument; and the transverse division of the organ was effected in exactly half an hour. The chain was then passed behind the base of the separated organ, and made to embrace the muscles and tissues attached to its under surface. In thirty minutes more this second part of the operation was completed, so that the entire time occupied was exactly one hour. The quantity of blood lost was quite insignificant, and the poor man did not evince great suffering. On the eighth day after the operation he was going on well.* A subsequent account reports the patient's recovery. A yet more serious and complicated proceeding consists in the introduction of the chain round the root of the tongue by means of an incision into the floor of the mouth from without. A second chain is required to free the severed tongue from the muscles and soft parts; this double operation takes about one hour for its completion.

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* *Med. Times and Gaz.*, May 14, 1859.

When the cancerous degeneration is limited to the side of the tongue, no such proceeding can be necessary, for the severed arteries are but small. But when the operation involves an extension beyond the mesial line, so that one or both ranine arteries must be cut across, and that, too, towards the base of the organ,—under such circumstances the écraseur may be used with advantage. With it may be combined the employment of the ligature, as in the following case. In 1859 I removed by the knife a cancerous mass from the left side of the tongue of a man aged forty-two. The hæmorrhage was considerable, the wound being very deep; but it ceased after the prolonged use of ice. The parts cicatrised completely, and the patient left the hospital apparently well. In ten months the disease returned in the cicatrix, and the patient came to me with the request that I would again remove the hardened parts, in order to give him even temporary relief from pain. As the induration extended quite to the mesial line, and the ranine arteries would of necessity be divided, I proceeded as follows:

Chloroform having been administered so as to produce complete insensibility, the tongue was drawn from the mouth by an assistant; the chain of a small écraseur, armed with a needle, was then passed through the middle of the tongue beyond the base of the tumour, and made to cut from within outwards, so as to sever the posterior connexions. Next a slight incision was made with scissors into the point of the tongue, so as to guide a ligature round the remaining attachment of the partially severed mass. A strong knot was tied, the prominent part cut away, and the patient was removed to bed.

In December 1861 Mr. Nunneley described, before the Medico-Chirurgical Society of London, the particulars of an operation for the complete extirpation of the tongue, in which it was asserted the cure had been permanent for some months. A small incision was made anterior to the os hyoides through the integument, mylohyoid, and geniohyoid muscles, by which a curved needle, to which was attached the chain of the écraseur, was introduced so as to carry the chain completely round the base of the organ. In consequence of some imperfection in the chain, it was removed; strong whipcord was substituted, and tied with all the force possible. During the course of treatment hæmorrhage supervened, but it was easily arrested by a solution of tannin. Ultimately the organ came away, and the wound cicatrised. Some doubt, however, was expressed by the society as to the exact nature of the disease.*

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* *Med. Times and Gaz.*, Dec. 21, 1861, p. 648.

The tongue has been completely extirpated by the knife. Regnoli has removed large portions by making an incision into the floor of the mouth from one angle of the inferior maxilla to the other. But Mr. Syme first, and subsequently Mr. Fiddes,* have extirpated the entire organ, by making an incision through the lower lip, chin, and lower jaw, pulling aside the two halves of the bone, and dissecting the diseased mass, which is by these means fully exposed, from the os hyoides. Mr. Fiddes points out the importance of securing one lingual artery before the other is divided. He has operated thus twice, and speaks well of the results of his cases. The proceeding has not, however, yet found favour generally with modern Surgeons.

Now, in cancer of the tongue the greatest distress to the patient arises, first, from the pain in every movement of the organ, extending to the ear and over the side of the head; and secondly, from the profuse flow of saliva, which keeps him constantly wet and unable to articulate with comfort. The idea of diminishing the sensibility of the tongue, and of checking the excessive secretion by the division of the gustatory nerve as it lies close to the ramus of the jaw, suggested itself many years ago to Mr. Hilton;† and Mr. Moore, of the Middlesex Hospital, has recently repeated the operation. By dividing the gustatory nerve, he remarks, between the disease and the brain, all the consequences of the irritation of that nerve are necessarily suspended. No sensation from the tumour can be conveyed along it; no reflected irritation can reach the collateral branches of the fifth nerve; no stimulus to an exaggerated secretion of saliva can be given to the salivary glands. A patient on whom this operation has been performed should speak more freely, and swallow with less difficulty; should be relieved of pain in the tongue and jaw, temple and crown of the head, and of the incessant annoyance arising from the dribbling of saliva; he should sleep better, and be better nourished than before.

The mode of performing the operation, as adopted by Mr. Moore, differs in some respects from that adopted by Mr. Hilton. The latter Surgeon sought for the nerve in the floor of the mouth, and exposed it by making an incision along the mucous membrane close to the sublingual gland. The former divides the nerve just behind the last molar tooth, as it escapes from the cover of the pterygoideus internus muscle. It is not more than half an inch distant from the tooth, and is covered only by mucous membrane.

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* *Edin. Med. Jour.*, June 1859.

† *Guy's Hospital Reports*, vol. vii. p. 263.

The guide to the nerve is the last molar tooth. On passing the finger into the mouth, within and beyond that tooth, the bulging alveolar ridge can be felt narrowing as it ascends into the thin ramus. Behind, below, and parallel with the ridge, is a shallow groove in the bone. The nerve passes along that groove. Therefore an incision three quarters of an inch in length made within the mouth and down to the lower jaw behind the last molar tooth, and in a direction crossing the course of the nerve, must divide it. It is advisable to operate with a curved bistoury, since the alveolar ridge might shield the nerve.

The patients have expressed themselves relieved; the tongue being rendered completely numb.

Mr. Moore has combined with this operation ligature of the corresponding lingual artery, so as to cut off as much as possible the supply of blood to the affected part. The results are sufficiently encouraging to merit further trial.

HOLMES COOTE.

END OF THE THIRD VOLUME.

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